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THE AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

PAPERS AND PROCEEDINGS OF THE 14th ANNUAL MEETING

OF THE

AMERICAN MOSQUITO CONTROL ASSOCIATION

HELD JOINTLY WITH THE VIRGINIA MOSQUITO CONTROL ASSOCIATION, UNDER THE SPONSORSHIP OF THE A.M.C.A. SOUTHEAST CENTRAL REGION, WASHINGTON, D. C., FEBRUARY 23–26, 1958

PART I

THE RELATION OF MOSQUITO CONTROL TO DEFENSE

REAR ADMIRAL E. J. PELTIER, CEC, USN
Chief of Civil Engineers

INTRODUCTION. Members and Guests of the American Mosquito Control Association:

The opportunity to meet and exchange ideas with you at this Fourteenth Annual Meeting is a very timely and welcome one, timely because the nature of my subject concerns planning on a problem of mutual concern to you and me; and welcome because through this occasion, we can discuss a subject that needs the wisdom, experience and guidance that you possess. There can be no doubt of your practical wisdom as it is demonstrated by your selection of this date for your meeting. We residents of the Washington area greatly appreciated the selection of February, since we are certain to be spared any embarrassment from having the local mosquitoes appear on the welcoming committee. With such diplomacy in evidence, I am sure that the question contained in my subject will be equally well treated.

What is the relation of mosquito control to defense?

To answer this directly would imply that I spoke for the entire Department of Defense. The background and examples I use are Navy; but as so many of you know, our experiences are similar to those of the Army and Air Force and, therefore, in many instances are representative of military interests.

Let us for the moment talk about the relations between the American Mosquito Control Association and Defense activities as they are today.

I am sure that the first thought that many of us have is of a community where the local Mosquito Abatement District and a military activity are working together. Their mutual goal is to make the entire community a more enjoyable and safer place in which to live. A few of the examples that come to mind are Key West, Jacksonville, Norfolk, Newport, Vallejo, and Honolulu. Some of us have met and planned for common use of materials, equipment, and personnel to solve a common problem. The result has been a gratifying improvement of living conditions at a reduced cost to both civilian and military communities. Surely this is an example of cooperation worth remembering. Other examples of military agencies and civilian communities working hand-in-hand are emergencies and disasters.

Military assistance in the form of aerial spraying flights, ground operational crews and equipment, and professional personnel has been coordinated through the Public Health Service in hurricanes, floods and similar emergencies during the past few years.

A less direct benefit of our relationship is that of technical and operational train-

ing. The conferences, seminars, and work shops established by American Mosquito Control Association and its regional and local counterparts have been of much value to military personnel. Our knowledge of how to cope with practical mosquito control problems and related community problems, has been substantially increased. In turn, it is our hope that techniques, equipment and materials developed by some of our research efforts have been of value to you.

The emphasis placed by both the American Mosquito Control Association and the military departments on the betterment of training and efficiency is improving the general knowledge of the public on the importance of this work. Every citizen must cooperate if mosquito control is to reach the highest degree of effectiveness. Each effort to reach more people and acquaint them with what they can do about mosquito control problems contributes to our common benefit. Thus it can be said that our present relationship is accomplishing much and furnishes a firm foundation for future planning.

Now let's take a quick look at what our relations may be in the future especially in the event of a major emergency. It is difficult to prophesy what the future may have in store under any circumstances. A look at past problems may give you some ideas. By 1946 the military and civilian efforts to achieve effective mosquito control were considerable, but not before some very sad lessons had been learned.

In 1942 malaria began to build up in several of our critical civilian manufacturing areas and a program had to be hurriedly organized to make continued industrial support from these localities possible.

In the Army and Navy, 1942 to 1945, over 830,000 medically recorded cases causing a loss of over 14 million man-days were due to diseases borne primarily by mosquitoes. This was the equivalent of more than ten thousand men for the entire period. During the Korean conflict mosquito-borne diseases again accounted for a huge loss of manpower.

Today our Medical Departments advise us that yellow fever is again showing up in animals in Latin America. We are also told that the potential has been extended to the Gulf States. Add the knowledge that more and more evidence is being found to indicate the serious nature and potential of mosquito-borne encephalitis.

Our past experiences indicate that sources of malaria become more difficult to hold in check under emergency or disaster conditions.

The conclusion to be drawn is that the successful peacetime mosquito control operations must be continued under emergency conditions.

With this fact established, what type of obstacles under emergency conditions might tend to disrupt the continuation of successful community control operations? I believe the problems may be summarized in the following areas:

1. *Personnel*—The loss of trained key personnel due to manpower demands.

2. *Support*—The nation's resources and attention will be directed toward dramatic developments of an emergency.

3. *Disorganization*—The neglect of drainage facilities, sanitation practices and operations essential to mosquito control due to emergency conditions.

In the event of enemy attack, these facilities which we normally take for granted may be seriously disrupted or destroyed completely.

These factors appear, and are, formidable to any organized effort to keep an operating program effective.

But we are faced with the equal realization that as these factors increase with the intensity of the emergency so do the conditions favorable to mosquitoes and the health and morale problems they cause.

Organizing combined efforts of interested agencies at that time would be difficult and too late.

Thus the picture becomes one of much more to do and much less to do it with UNLESS every effort for pre-emergency planning is made.

The Navy, or any other agency that

plans alone, is not in a position to guarantee maximum use of all facilities that might be jointly used.

Consultation with Public Health Service, Federal Civil Defense, the military departments, and state and local agencies might make such a total effort possible. Some planning of this nature has already been accomplished. However, it is likely that your organization more than any other has membership that represents many of the interested agencies.

Your organization has the dedicated interest combined with the experience on how good community programs operate.

In view of this experience, would it not be appropriate that methods for furthering a plan for the coordinated action of all agencies concerned be considered by the Members and Directors of the American Mosquito Control Association? The completion of such a plan may assure that a necessary level of performance can be maintained in time of emergency. This I recognize as a Herculean task but unless every effort is made now while there's time for planning, it may never be done. I believe it can be done and that the accomplishment will be worthy of the effort in a nation-wide concept of defense.

MORE ABOUT MALARIA ERADICATION

FRED L. SOPER

I rejoice in the opportunity to talk "More about Malaria Eradication" to the members of the American Mosquito Control Association. The title is purposely vague even though the objective of the program for malaria eradication is quite specific; literally the termination of the infection of the human race by all species of Plasmodium.

For the skeptics, who may doubt the modern occurrence of miracles, I would say that the miracle of world malaria eradication has become inevitable as a result of technical, political and financial miracles of recent years.

Only a brief two decades ago, Dr. Mark Boyd,[1] a life-long student of malaria in the United States and abroad, asserted in his 1938 Presidential Address to the American Society of Tropical Medicine, 1. that malaria control would have to depend on local programs paid for by the populations to be benefited; 2. that the financing of such programs could best be carried out through small, annual payments; 3. that malaria was not a problem to require the quick assembly of relatively large funds for its immediate suppression; 4. that malaria was to be attacked, not through a rapid campaign but through long term effort for gradual improvement. To Boyd it was obvious that permanent results could best be gotten by "building-out" malaria through permanent drainage and filling projects.

Today, 1958—20 years later—the nations of the world, banded together in the World Health Organization and the Pan American Sanitary Organization are engaged in a world-wide effort to eradicate malaria from the human race through a coordinated, simultaneous campaign to be completed within a comparatively short period of time, at a cost far beyond the local financial resources of many malarious areas.

The eradication program is based not on building malaria out, but rather on the prevention of the transmission of infection by chemical attack on such vector mosqui-

[1] Malaria: Retrospect and Prospect. Published in the American Journal of Tropical Medicine, Vol. 19, No. 1, Jan. 1939.

toes as enter human habitations. This attack must continue until such time as the infection dies out in the human host. Such a program carried out by a local community or attempted on a small scale, would be doomed to failure because of the reintroduction of the plasmodia from outside. Today's program calls for complete coverage of all malarious areas by national malaria services throughout the world. Financial assistance and technical coordination are available through WHO, PASO, UNICEF and ICA.

I submit that this present situation has been developed only on the basis of what must be considered, from the viewpoint of 1938, as technical, political, and financial miracles. It is not too much to anticipate that the additional miracles necessary to get sustained support and administrative efficiency required to finally eradicate malaria may well be forthcoming in the face of the faith and courage which are being displayed by, not only those who are responsible for the technical aspects of the eradication campaign, but also those who have to take the responsibility for the political and financial commitments.

The history of malaria control and eradication in the United States shows that, even here, anti-malaria measures have depended over the years, to a large extent on funds other than those which could be raised from the highly malarious communities themselves. Malaria control in the United States may be said to have begun with the work of Gorgas in Havana in 1901; the anti-malaria work in the Panama Canal Zone in the following years was largely responsible for setting the pattern of malaria control measures used in the United States until after the introduction of paris green in 1921. In the beginning, within the United States itself, malaria control was limited to isolated, local efforts based on drainage, filling, screening, and oiling. Real increases of malaria control and its popularization have depended, to a great extent, on funds made available from Federal and State sources to meet specific crises in the life of the nation. The first great period of development was in World War I when Federal, State and local funds were used to control malaria, particularly around recruitment and training centers in the southern part of the United States. The second great impact resulting in multiplying anti-malaria work was caused by the economic crisis of the 1930's when thousands of laborers on public relief were available to carry out public works. Advantage was taken of this by the Public Health Service to get considerable extension of anti-malaria activities. The third great impact on malaria, and that which led to its eradication in the United States, was the crisis of World War II, during which the establishment of numerous training camps and the development of war-time industries in the south led to the organization of extensive malaria programs, financed by Federal, State, and local funds.

The pattern which developed in the United States between 1900 and 1950, was for a national crisis to loose the national purse strings and permit the expansion of malaria control activities.

An important part of the pattern was that successful control programs, once undertaken with emergency funds, were never or almost never, allowed to lapse. Either the augmented wellbeing and the recognition of its importance caused the people, following malaria control, to demand its continuation; or obviously improved economic conditions permitted continuation of what was previously beyond financing from local resources.

With the expansion of anti-malaria measures in the United States during World War II, by 1943, anti-malaria campaigns were active in many of the 120 malarious counties, none of which were heavily infected. Complete national coverage was planned and in 1945 Congress appropriated funds to extend operations to all areas where malaria transmission was occurring; for the first time, the United States had a nation-wide malaria campaign. In 1947, the Congress recognized

the nature of this effort and appropriated funds for "The National Malaria Eradication Program."

The nation-wide campaign plan of 1943 was predicated on the use of paris green as a larvicide. Although larviciding with paris green could have led to success, eradication was greatly facilitated by the introduction of DDT as a residual insecticide to be sprayed on the inner walls of human habitations. From 1945 on, the use of DDT made the human habitation the determining unit of cost rather than the surface of anopheline breeding areas.

By 1947, it was obvious that indigenous malaria had been halted in the United States and by 1950 close observers were convinced that malaria eradication had been achieved. This eradication, it should be emphasized, could occur when it did, only because of the outpouring of federal funds as part of the war effort, during and immediately after World War II and through the coordination of State and local programs by the U. S. Public Health Service.

Other malarious countries began to use DDT and to develop the concept of eradication during and immediately after World War II; in Europe, demonstrations in Italy in 1944, and in Greece in 1945 gave rise to nation-wide campaigns, and in the Americas, campaigns covering most of the populations of Venezuela, and British Guiana were inaugurated in 1945.

In 1950, at a symposium on "Nation-wide Malaria Eradication Programs," under the auspices of the National Malaria Society at Savannah, programs in Brazil, British Guiana, the United States and Venezuela were presented for discussion.

In 1950, a reconnaissance [2] of the malaria control programs in the Americas was made under the auspices of the Pan American Sanitary Bureau. The report of this reconnaissance was submitted to the XIII Pan American Sanitary Conference meeting in Ciudad Trujillo the same year. The Conference instructed the Pan American Sanitary Bureau ". . . to provide for greatest intensification and coordination of anti-malaria work in the hemisphere, stimulating existing programs, facilitating interchange of information and furnishing technical and, whenever possible, economic assistance to the various countries with a view to achieving the *eradication of malaria from the Western Hemisphere*."

The succeeding years proved that the time was not ripe for an all-out effort at eradication. Too much publicity had been given to the marked malaria reduction which had occurred as the result of the introduction of DDT and some resistance to even the continued expenditure of the sums then being devoted to malaria control had been developed by a number of Ministers of Finance. In the meantime, the attempt made by the Pan American Sanitary Bureau to combine programs for the eradication of the *Aëdes aegypti* mosquito and malaria failed to prove administratively advantageous. By the end of 1953, the recurrence of malaria in certain countries where control measures had been neglected, and the demonstration of the existence of resistance to chlorinated insecticides on the part of certain anopheline mosquitoes, caused a change of atmosphere.

A second reconnaissance [3] of the malaria situation in the Americas, carried out in 1954, indicated that no noteworthy progress had occurred during the previous four years. The situation was reported to the XIV Pan American Sanitary Conference at Santiago, Chile, in October 1954 and an emergency resolution, actively supported by the United States Delegation, was passed, calling upon the Pan American Sanitary Bureau to take more effective

[2] Alvarado, Carlos A., 1950, "IV Informe de la lucha anti-malárica en el Continente Americano," submitted to the XIII Pan American Sanitary Conference, Ciudad Trujillo, 1–10 October 1950.

[3] Alvarado, Carlos A., 1954, "Status of the Antimalaria Campaign in the Americas V Report," presented to the XIV Pan American Sanitary Conference, Santiago, Chile, October 1954, as Annex I of Document CSP14/36 (PASB Sc. Pub. No. 27, December 1956).

measures to implement the resolution of the XIII Conference calling for the eradication of malaria in the Western Hemisphere. An emergency fund of $100,000 for administrative purposes was approved for 1955 and authorization given for a special voluntary malaria eradication fund, with the participation of organizations, public and private, national and international, in order to achieve eradication. Plainly the first international body to envision continental eradication of malaria now realized that lack of funds had been a significant deterrent to success.

Just as the expansion of anti-malaria work in the U.S.A. depended, during half a century, on the availability of funds other than those of the local malarious communities themselves, the success of the world malaria eradication program inevitably depends on the financial support of economically able countries.

None of those attending the XIV Conference could possibly have foreseen the rapidity of developments which have followed the action of this Conference. Only a few of the highlights of the intervening period can be mentioned here. (a) In January of 1955 the President of Mexico authorized the Minister of Health to arrange, if possible, for the financing of a Malaria Eradication Program for this country, considered at that time to be one of the principal reservoirs of malaria transmission in the Americas. (b) The International Cooperation Administration joined in stimulating the conversion of control to eradication programs and has actively supported the concept of malaria eradication whenever its interest has been felt. (c) In March 1955, the United Nations International Children's Fund, on the basis of an initial request from Mexico, tentatively approved malaria eradication as a field for UNICEF commitments and at the same time decided to curtail future participation in partial control programs. UNICEF commitments for malaria eradication have amounted to many millions of dollars and have been of signal importance because of their early availability as well as of the relatively large amounts committed. (d) In May of 1955 the WHO/UNICEF Joint Committee on Program Planning approved malaria eradication as a field for combined activities. (e) In May 1955, the Eighth World Health Assembly meeting in Mexico City, after hearing the first official commitment of the Government of Mexico to eradicate malaria, approved a resolution for the development of a coordinated program for the eradication of malaria throughout the world, and established a special malaria eradication fund. (f) During 1955 and succeeding years there has been a widespread acceptance on the part of governments throughout the Americas, and, to an important extent, in other parts of the world, followed by the consequent planning for the conversion of control efforts to nation-wide eradication programs. (g) In 1957, a Special Committee of the Representatives of the Presidents of the American Republics approved the Malaria Eradication Program in the Americas for special consideration. (h) Early in 1957, contributions to the special Pan American Malaria Eradication fund were received from the United States in the amount of one and one-half million dollars, from Venezuela three hundred thousand dollars and from the Dominican Republic one hundred thousand dollars. (i) One of the most significant developments since action of the XIV Conference in 1954, is the action taken by the Congress of the United States with regard to malaria eradication in the Mutual Security Act of 1957. Recommended reading for those interested in broad international statemanship is to be found in the hearings on this Act before the Committee on Foreign Relations of the U. S. Senate, pp. 576 to 590. To quote, "In 1955 the World Health Assembly unanimously adopted a Resolution giving top priority to the support of eradication. More than sixty free nations have malaria within their borders. Although nearly all of these nations have embarked on eradication programs, they are for the most part not economically able to wage an effective war against this ancient enemy.

"Since the World Health Assembly ac-

tion in 1955 pressure and enthusiasm in the underdeveloped countries has continued to mount. This pressure has been reflected in the increased anti-malaria activities of the international organizations, notably the World Health Organization, UNICEF and the Pan American Sanitary Organization.

"However, it is clear that in order for this great goal to be achieved, the United States must spark an all-out effort utilizing all available resources national and international. The proposed program provides for such an effort and if adequately supported and energetically prosecuted by all elements should result in the eradication of this dread disease in many areas within five years time."

Under this Act five million dollars has been made available to the special malaria account of the World Health Organization, two million dollars has been contributed to the special malaria fund of the Pan American Sanitary Bureau, and sixteen million three hundred thousand dollars is to be used by the International Cooperation Administration for the support of national malaria eradication programs in various countries of the world.

It must be emphasized, that a clear distinction is made in the use of these funds between Malaria Control Projects and Malaria Eradication Programs.

A malaria control project may have a limited objective of reducing the incidence of malaria in a given area at a given time; it may be a pilot or demonstration project, may be limited to the most malarious, to the most heavily populated or to the most economically important malarious areas. The control project has limited objectives and involves limited commitments.

The definition of the malaria eradication program may be given in the terms established by WHO for eligibility of programs for assistance from the Special Malaria Fund:

"Before a country is eligible for assistance in malaria eradication, it must be determined that such a programme is, for that country, technically, administratively and practically feasible. A programme for malaria eradication must be country-wide, with the specific goal of eradication, although it may be carried out in stages in different parts of the country.

"Countries to which help is given must be prepared to take all necessary action—legislative, financial and administrative—and be able to recruit staff, provide locally-produced supplies and equipment, and to grant all facilities necessary to the success of the programme. Malaria eradication is different from other projects carried out with WHO assistance in size, duration and objective. Governments should undertake such programmes only when they can and will take the actions necessary to ultimate success—otherwise, the effort will be wasted, and failure to achieve eradication will have not only internal repercussions but may jeopardize the eradication programmes of neighboring countries."

No attempt can be made here to report on progress in individual countries. Suffice it to say that Governments are calling on WHO, PASO, UNICEF, and ICA for malaria eradication programs faster than personnel can be trained to develop and administer those programs.

Accumulated demands have recently exceeded the available capacity of insecticide production and caused a sudden rise in the price of DDT of some 20 percent.

Eradication has progressed far enough in the Americas, in Europe, in the Eastern Mediterranean, in S.E. Asia and in the W. Pacific to convince the specialists that no insoluble problems are anticipated, if adequate financing can be had. There is little information regarding malaria in the Communist areas but such reports as exist are optimistic. Africa has problems but these may well be largely economic and administrative rather than technical. The vastness of the malarious area of Africa, the lack of roads, the low economic status of the people and the intensity of their infection are frightening to local authorities and awesome to distant ones. Each of these impediments has been surmounted here or there and from time to

time even in the heart of Africa. All of them can be overcome by the ingenuity of malariologists, provided only that funds in sufficient quantity be forthcoming in due course.

In April 1901 Sir William McGregor [4] wrote to Ronald Ross, "I shall be glad to send you a few notes on malaria in the field, what we are doing and what lions roar at us in the path. So far the greatest obstacle is the Colonial Office. It is bad enough to have to deal with malaria alone; but malaria entrenched behind Sir ——— is impregnable." If I were to paraphrase Sir William's words for the American Mosquito Control Association today, I might do it thus, "I have been very glad to give you a few notes on the world malaria eradication program, what the international organizations are doing, and what lions are aiding and abetting us in the task. So far the greatest acceptance of the concept of eradication has been noted on the part of practically all of the malarious countries of the world and the fullest recognition of their responsibilities and opportunities must be recorded for the non-technical elements of certain governments, especially the government of the United States and certain others which have come forward with voluntary contributions to the support of the world programme. Certain doubts which must have clouded the vision of the early supporters of the campaign for the world eradication of malaria have been cleared, and it can be said that this campaign, adequately financed by the economically able countries of the world, is bound to succeed."

In his state of the union message to the Congress on January 9, 1958, President Eisenhower said, "Another kind of work of peace is cooperation on projects of human welfare. For example we now have it within our power to eradicate from the face of the earth that age old scourge of mankind: malaria. We are embarking with other nations in an all-out five-year campaign to blot out this curse forever."

The United States has been free of malaria for a decade and now makes available for malaria ridden countries a very small part of what this disease used to cost the USA economy. Should other countries, similarly, as they become free of malaria, contribute a portion of the funds the disease previously cost them, the snowballing effect of these contributions will be notable in speeding the final solution of the malaria problem.

[4] Memoirs: Ronald Ross—John Murray, London, 1923, p. 458.

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EFFECTS OF GROWTH OF *AEDES AEGYPTI* L. LARVAE ON A CHEMICALLY DEFINED MEDIUM *

K. R. P. SINGH AND DON W. MICKS
Laboratory of Medical Entomology, Department of Preventive Medicine and Public Health, The University of Texas Medical Branch, Galveston

INTRODUCTION. Normal development of an insect on a synthetic diet depends not only upon the presence of all the required chemicals but also upon the ability of the insect to utilize them. Since many insects live in the food on which they feed, their normal growth and development is affected both by the dietary constituents *per se,* and the physical environment created by their presence. Furthermore, insects in an aseptic medium are constantly adding metabolites, which in nature might be utilized by other organisms present in the environment of the insect. These metabolic products of insect excretion may produce an imbalance in the physical and chemical nature of the chemically-defined diet with subsequent effects on insect growth and development.

Although considerable care is taken in nutritional work to adjust the pH and other factors of the diet, little attention has been given to the physical environment which the diet provides. Recently, the importance of osmotic pressure in the growth of *A. aegypti* in a chemically-defined diet has been demonstrated (Singh, 1957; Singh and Brown, 1957). Likewise, the role of surface tension in the development of mosquitoes has been emphasized (Singh and Micks, 1957).

In order to elucidate some of the changes which occur in a chemically-defined diet due to the presence of the developing insect, the effects of growth of *Aedes aegypti* larvae on pH, viscosity, surface tension, osmotic pressure and the amino acid level of the diet were investigated.

MATERIALS AND METHODS. *Aedes aegypti* larvae were grown on a chemically-defined medium developed by Singh and Brown (1957). On this diet, *A. aegypti* larvae generally complete the first instar on the fourth day, the second instar on the seventh day, the third instar on the tenth day and pupation occurs on the fourteenth day. Each tube of rearing medium contained 50 mg. of the solid fraction of the diet and 6 ml. of the liquid fraction. Three sets of tubes containing the chemically-defined diet were inoculated with 1, 2, and 4 first instar larvae respectively, while a fourth set, containing no larvae, was kept as a control. All experiments were performed in duplicate. Observations on pH, viscosity, surface tension, osmotic pressure, and amino acid levels of the medium were made on the first, fourth, seventh, tenth and fourteenth days.

Viscosity was measured with an Ostwald viscosimeter in minutes, as the difference between double distilled water and the diet. The pH was recorded with a Beckman glass electrode pH meter. The surface tension readings were taken with a Harkins drop weight apparatus (Harkins and Brown, 1919; Harkins and Harkins, 1929). The osmotic pressure was obtained using the Beckman cryoscopic method and is recorded as freezing point depression. Amino acid levels were measured chromatographically. Chromatograms were made by spotting 0.01 ml. of the medium on 3 mm. Whatman filter paper and were run, developed and read according to the methods previously described (Micks and Gibson, 1957). Total amino acid levels are represented as density curves derived from 0.01 ml. of material and recorded as area per cm.^{2} with a K & E, compensating polar planimeter.

In order to obtain a more accurate comparison, all values were corrected against the values of double distilled water on any

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particular day and against the average mean of the first day's values in each set of experiments.

RESULTS. The growth and development of *A. aegypti* larvae in the defined diet produced definite physical and chemical changes in it. Although there was no appreciable change in the pH throughout the experiment, the viscosity was altered (Figure 1). Tubes with one and two larvae (75.5 dynes/cm.) was higher than the others at four days, and yet was the lowest at 10 days, dropping to approximately 68 dynes/cm. The medium containing one larva was lower than the controls throughout this period of time. There was a subsequent rise in the surface tension of all tubes to the fourteenth day.

The osmotic pressure showed a continuous rise in all tubes during the period

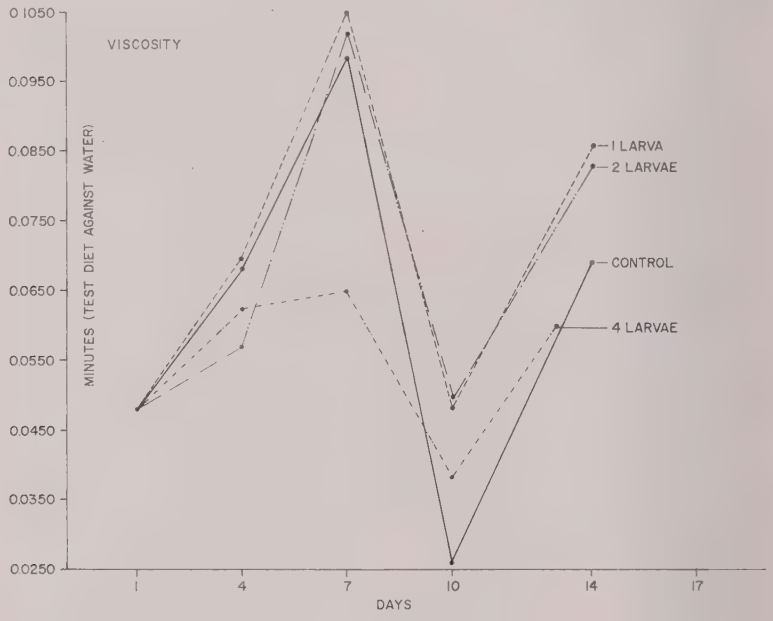

FIG. 1.—A comparison of the viscosity of media containing 1, 2 and 4 larvae with the control.

larvae largely followed the controls until the tenth day at which time the viscosity of the media with the larvae dropped to approximately 0.0500 min. while that of the controls fell to about 0.0250 min. From this point on, the viscosity remained higher in these test groups. On the other hand, it remained lower in the tubes containing four specimens, never exceeding 0.0650 min. at any recorded interval.

The effects of *A. aegypti* larvae on surface tension were essentially the reverse of their effects on viscosity (Figure 2). The surface tension of the diet containing four

of the experiment except between the fourth and seventh days when there was a slight drop in osmotic pressure in media with both two and four specimens (Figure 3). The effect of four larvae per tube on the osmotic pressure of the medium was very evident. Following the marked drop on the seventh day to $\triangle 0.330^\circ$ C., there was a subsequent rise to a maximum of $\triangle 0.390^\circ$ C., as compared with $\triangle 0.490^\circ$ C. in the controls. In general, the osmotic pressure increased with a decrease in the number of specimens.

Amino acid levels increased steadily in

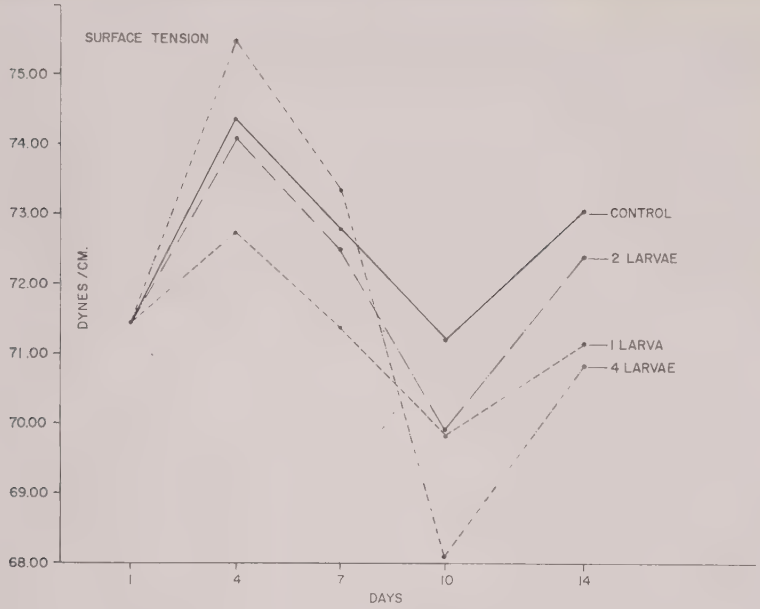

FIG. 2.—A comparison of the surface tension recorded for all test and control media.

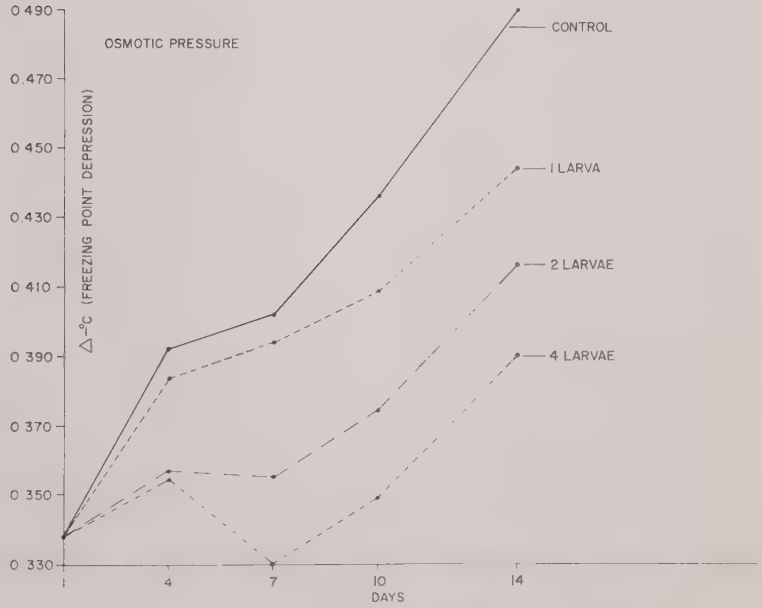

FIG. 3.—Changes in osmotic pressure of the test and control media during a 14-day observation period.

all sets of experiments until the seventh day when the media with four larvae and the controls began to drop (Figure 4). In tubes with one and two specimens, the amino acid levels continued to rise until the tenth day and then decreased. The density curves obtained from media with four larvae per tube were similar to those of the controls except for slightly higher values in the test medium on the seventh and tenth days. Figure 5 shows that the free amino acid content of the media containing a single larva is appreciably higher than that of the controls. This increase occurs in those areas represented by lysine, glycine, serine, histidine, alanine, threonine, methionine valine, leucine and isoleucine.

DISCUSSION. It is apparent that the larval medium is not a static phase in which the insect lives and completes its development with merely an accompanying reduction in the various essential nutrients. On the contrary, this environment undergoes dynamic changes resulting from the interactions between it and the growing larvae. The changes in the control media are difficult to explain but may be due in part to evaporation and certain chemical reactions. The long period required for development of the larvae in the diet may indicate that various essential components become less and less available as growth proceeds.

The fact that media containing the greatest number of larvae (4) exhibited the lowest viscosity is probably due to their greater utilization of the available food. Furthermore, even though the surface tension varied considerably from one experimental group to another, it remained within the normal limits in which most mosquito species develop (Singh and Micks, 1957). The steady increase in osmotic pressure during larval development is probably the most important limiting physical factor. It has been demonstrated by Singh (1957) and Singh and

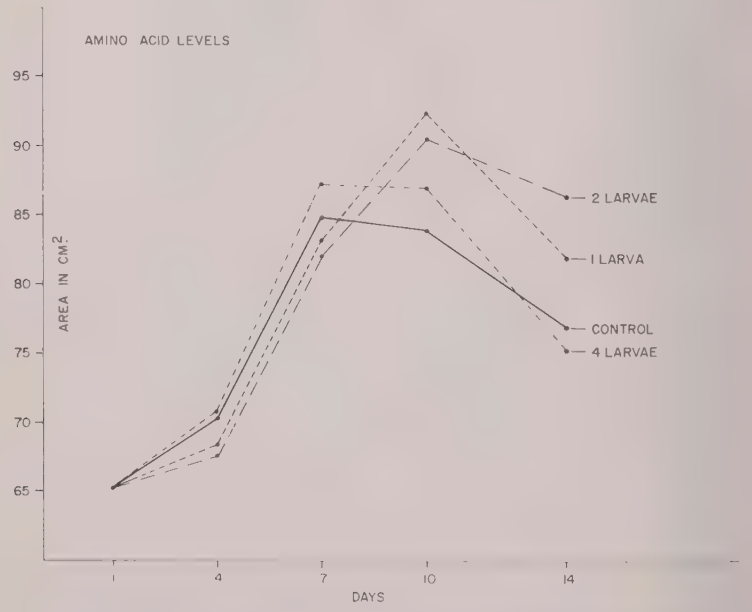

FIG. 4.—Levels of free amino acids in test and control media.

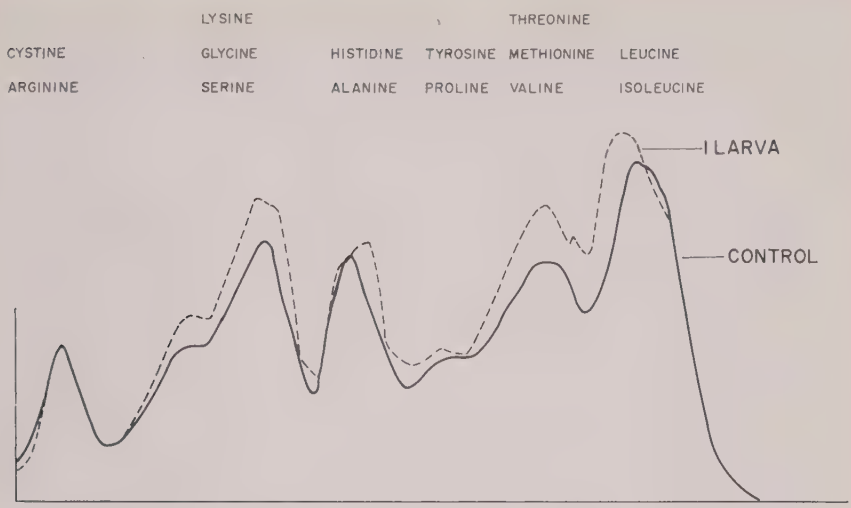

FIG. 5.—Density curves obtained from one-dimensional chromatograms of rearing medium which contained one specimen and the control medium, on the tenth day of the experiment.

Brown (1957) that larvae can survive and utilize dissolved amino acids provided the osmotic pressure of the diet does not exceed $\triangle 0.40^\circ$ C. This observation would seem to indicate that the increase in free amino acids in the media containing only one or two larvae was due in part to the high osmotic pressure. Under these conditions the larvae could not effectively utilize the amino acids. These results provide support for our general observations that larvae show better growth when there are several of them in the medium.

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CONTROL OF *CULICOIDES MELLEUS* (COQ.) (DIPTERA: HELEIDAE) IN SMALL PLOTS, WITH BRIEF DESCRIPTIONS OF THE LARVAE AND PUPAE OF TWO COASTAL *CULICOIDES*[1]

HUGO JAMNBACK,[2] WM. J. WALL,[3] AND D. L. COLLINS[2]

Many cottages on Long Island have been built near salt marshes and protected sandy beaches which are the breeding areas of coastal *Culicoides*. People living in these cottages often find outdoor activities unpleasant or even unendurable because of these insects.

ANNOYING SPECIES. To determine which species are the most important pests in these areas, annoying adult *Culicoides* were collected in June, July and August over a three-year period. Collections were made by capturing the flies in vials of alcohol. Only those that were actually biting or that caused annoyance by crawling on the face and body were collected. Foote and Pratt (1954) recorded three species of *Culicoides* as being particularly abundant and annoying along the eastern seaboard. As might be expected, we found these species, *C. canithorax* Hoffman, *C. furens* (Poey) and *C. melleus* (Coq.), to be the chief pests on Long Island. *C. melleus* was the most abundant of these species in mid-summer, during the peak of the "tourist season" (fig. 1). *C. furens* was also present during this period but in smaller numbers. *C. canithorax* was abundant in early and late summer, declining greatly in numbers in mid-summer as was noted by Dove *et al.* (1932). Beck (1952) stated that this species is taken in very large numbers during the spring months in Florida.

Since *C. melleus* appeared to be the most important nuisance species, at least from the point of view of summer residents, resort owners, and vacationers, experiments were made to determine the feasibility of reducing larval populations with insecticide. The sampling methods used in these studies, together with notes on the life history, are given in a companion paper (Jamnback and Wall, 1958). This species is unusual in that it breeds only in sandy intertidal areas.

METHODS AND MATERIALS. Test sites were located on protected sandy beaches having high and relatively uniform *C. melleus* larval populations. The width of each plot extended from the low tide level to above the high tide level. The plots ranged from 880 to 2025 square feet. The insecticide was applied at about low tide. Measured amounts of 25 percent DDT emulsifiable concentrate were diluted with two gallons of water to obtain the desired dosages. The resulting emulsions were applied with a 5-gallon knapsack sprayer. DDT emulsion was first applied at the rate of 2.2 pounds * per acre. When this proved to be effective, lower dosages were tested. Larval samples were taken immediately before treatment, one day after treatment, and at irregular intervals thereafter. The results of these tests are summarized in table 1.

RESULTS AND DISCUSSION. Table 1 shows that *C. melleus* larval populations declined more than 90 percent one day after application of DDT emulsion at dosages of 1 pound (technical), or more per acre. A decline of 78.5 percent was recorded one day after a plot was treated with 0.5 pound per acre. Seven days after treatment the larval population in this plot had declined 97 percent, indicating that, with lower dosages, larval populations may continue to decline for several days. A plot treated with 0.3 pound per

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[3] Suffolk County Mosquito Control Commission.

* All dosages given refer to the amount of technical insecticide applied.

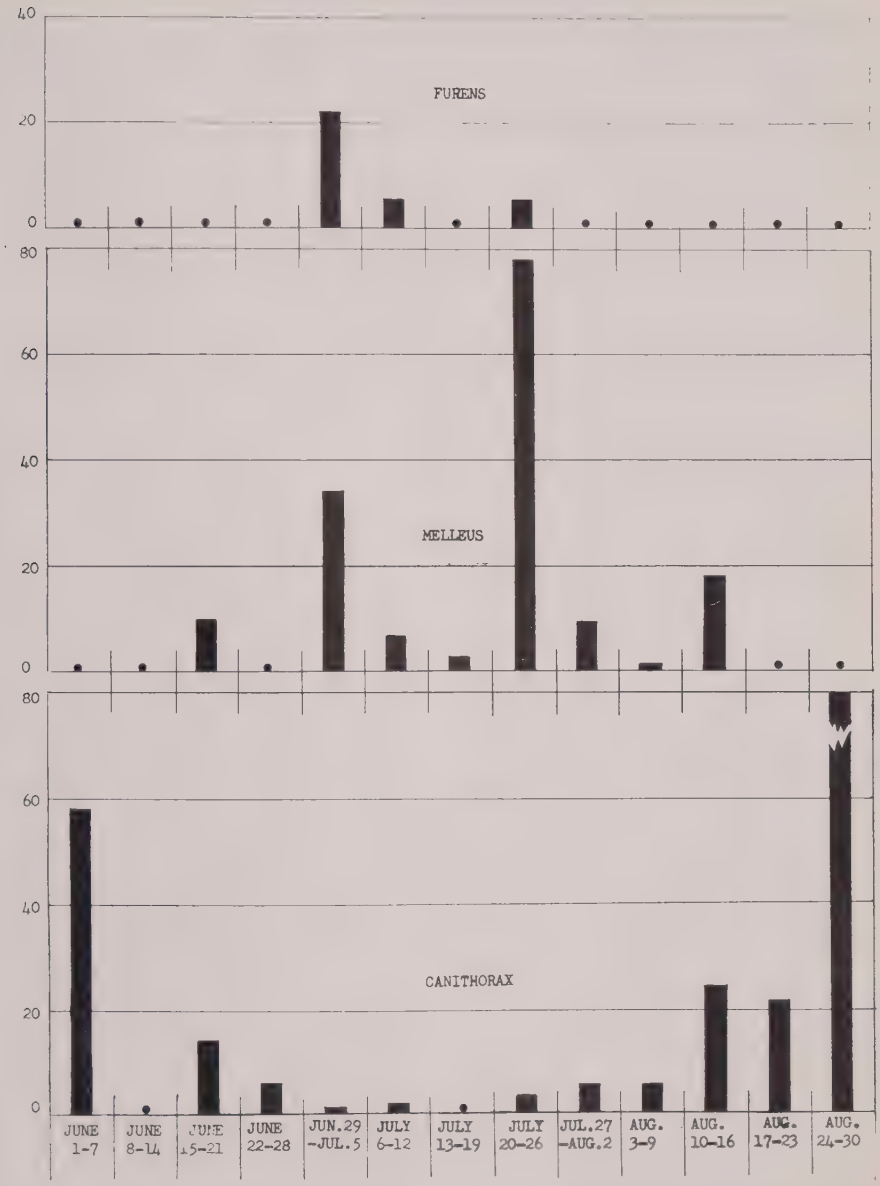


FIG. 1.—Collections of annoying coastal *Culicoides* on Long Island, 1955–1957. Each black bar represents the total weekly collection of a given species. A small black disc indicates that no individuals of that species were collected in the specified period.

Number of collections: 19 in June, 20 in July, 18 in August.

TABLE 1.—Control of *C. melleus* larvae in small plots with DDT emulsion

Dosage lbs./Acre	No. Days After Treatment	Average Number of Larvae		Percent Reduction*
		Treated Plot	Check Plot	
2.2	(before tr.)	50(3)†	50(1)	—
	1	0.7(3)	50(1)	98.6
	21	1(3)	42.5(2)	97.6
1.1	(before tr.)	26.7(3)	44.5(2)	—
	1	1.3(3)	36.5(2)	94.1
1.0	(before tr.)	28.3(3)	22.0(2)	—
	1	1.7(3)	16.5(2)	92.0
	21	8.7(3)	31.0(2)	78.1
0.5	(before tr.)	40.8(4)	44.5(2)	—
	1	5.8(4)	29.5(2)	78.5
	7	0.3(3)	11.0(2)	97.0
0.3	(before tr.)	50(3)	48.5(2)	—
	1	43.7(3)	46.5(2)	8.8
	3	43.3(3)	32.5(2)	(increase)

* Abbott's formula.
† Number of samples averaged given in parentheses.

acre showed no appreciable reduction one day or three days after treatment.

The data presented are considered preliminary since they are based on a small number of tests. Further tests using dosages of less than one pound per acre should be made, and larval populations checked daily for a reasonable period thereafter to determine whether lower dosages, although not so effective within 24 hours, may prove effective after a longer period.

If this method of *C. melleus* control were to be used on a large scale, it would be necessary to treat long strips of intertidal sand within a relatively short period while the tide is low.

DESCRIPTIONS. The immature stages of European species have been studied extensively (Hill, 1948; Lawson, 1951; Kettle and Lawson, 1952; Jobling, 1953, and others). Except for the *C. obsoletus* group, the European species apparently are not found in North America. Other North American species have been described and/or illustrated by Malloch, (1915), Painter (1926), Dove *et al.* (1932), Thomsen (1937), Fox (1942), Williams (1951) and Wirth (1952a, b).

Wirth described the larvae and pupae of *C. melleus* for the first time in 1952 (b). These stages of *C. canithorax* have apparently not been described previously. The following descriptions of the larvae and pupae of these two species are based primarily on reared specimens. Most of the characters used can be seen under a low-power dissecting microscope. They were selected by comparing the two species with each other, with some freshwater species, and with published descriptions of *C. melleus* and other species. In some instances, characters which are similar in *C. melleus* and *C. canithorax* but dissimilar in other species are included in the descriptions.

The names given to the sclerites, sutures, and ridges which make up the head capsule of *Culicoides* larvae differ considerably from one author to another. Jobling (1953) reviewed the terminology and gave a detailed description of the first instar larvae of *C. vexans* Stager. Unless otherwise indicated, we have followed his usage. Many of the structures used in the descriptions are labeled in the illustrations. The dimensions of the head capsule and parts of the pharynx were taken from cast skins of last instar larvae.

The terminology used by Lawson (1951)

in describing the pupae has been followed, for the most part. Fox (1942) and others have noted that the detailed shape and structure of the respiratory horn of *Culicoides* pupae is somewhat variable but that it usually has a characteristic appearance for a particular species. This is true of *C. melleus* and *C. canithorax*. The operculum of the male may differ slightly from that of the female in outline, but both have the same general pattern of spines. There are specific differences in the shape of the operculum and the pattern of spines. As was noted by Williams (1951) the angle of the apicolateral spines sometimes may vary from one specimen to another in a given species. For the two species described below it appeared to be fairly constant.

Culicoides melleus (COQ).

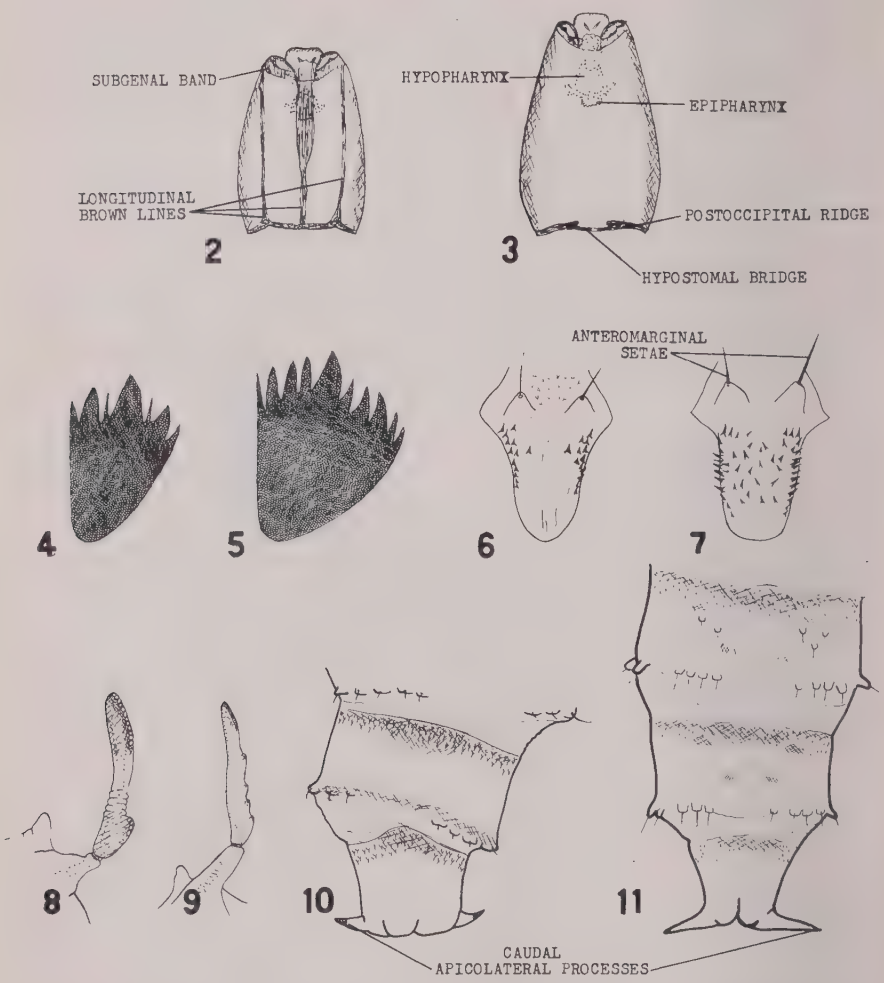
All of the reared specimens of *C. melleus* were collected from intertidal sand bordering the small bays or inlets of Peconic Bay. Two females were reared from larvae to adults, 3 females and 1 male were reared from larvae to pupae, and 7 females and 5 males were reared from pupae to adults (one male with a larval skin attached).

DESCRIPTION OF FOURTH INSTAR LARVA. Length about 4.4 mm. (a few up to 4.8 mm.). Dorsal head length 178 microns; greatest width 125 microns. Head capsule pale yellow with posterior margin delimited by light brown sclerotized ridge, consisting ventrally of the hypostomal bridge and laterally of the post-occipital ridge. Dorsally the posterior margin of the head (occipital and post-occipital ridges fused) not darkened. Ventral surface of head capsule with three narrow longitudinal brown lines extending anteriorly with hypostomal bridge, consisting of one median line and one on each side extending from posterior tentorial pits to light brown subgenal band (of Lawson, 1951), (fig. 2). These lateral lines appear to be homologous to the hypostomal membrane of Jobling (1953). Frontoclypeus with two indistinct lateral brownish longitudinal lines just mediad to the epicranial suture. These are best seen in cast skins. Epipharynx (mola cibarialis of Jobling, 1953) with dorsal comb about 25 microns wide, consisting of two halves; proceeding from the outermost tooth, each side usually with 3 smaller teeth a large tooth and 3 to 4 smaller teeth (fig. 4). This structure can usually be seen in cleared, slide-mounted whole specimens. Combs 2 to 4 (see Kettle and Lawson, 1952) present but difficult to distinguish except in dissected specimens. Suspensorial sclerites of hypopharynx about 51 microns apart at tips. Posterior fringe of hypopharynx about 4 microns long.

Thoracic and abdominal markings not apparent on most specimens whether preserved in alcohol or alive. A few specimens have diffuse dorsal and lateral darkening of the prothorax and somewhat more distinct light gray elongate dorsolateral markings (lateral bodies of Kettle and Lawson, 1952) on the meso- and metathorax. The anal segment bears short, inconspicuous setae, which are shorter than the width of the anal segment at the middle.

DESCRIPTION OF PUPA. Length about 2.4 mm. Pupal respiratory horn slightly more than one-sixth dorsal length abdomen, about 5 times as long as wide; distal section (beyond constriction) more than 3 times longer than basal section. Base of distal section with enlarged dorsal knob, narrowed beyond with transverse wrinkles; apex clavate. Basal section whitish, distal section dark brown except for white band across narrowed median portion; usually with 4 spiracular papillae at enlarged base of distal portion and a row of 16–22 spiracular papillae at apex (fig. 8). Operculum with large spines confined almost entirely to lateral margins posterior to anteromarginal setae (fig. 6). The two anterior seta-bearing dorsomedian tubercles on each side of the mesothorax confluent, not pigmented; appearing as transparent spots on yellowish background of pupal skins.

Abdomen without fine reticulate lines, with small spines scattered in irregular rows near anterior margins of segments



FIGS. 2–11.—Larval and pupal structures of *Culicoides melleus* and *Culicoides canithorax*.

C. melleus. LARVAE: fig. 2, head capsule, ventral aspect; fig. 4, dorsal comb of epipharynx (one side), ventral aspect. PUPAE ♀♀: fig. 6, operculum, lateral aspect; fig. 8, respiratory horn, lateral aspect; fig. 10, abdomen, posterior end, ventral aspect.

C. canithorax. LARVAE: fig. 3, head capsule, ventral aspect; fig. 5, dorsal comb of epipharynx (one side), ventral aspect. PUPAE ♀♀: fig. 7, operculum, lateral aspect; fig. 9, respiratory horn, lateral aspect; fig. 11, abdomen, posterior end, ventral aspect.

and elongate seta-bearing tubercles mostly near posterior margins of segments. Abdomen without dark pigmented spots but with faint, narrow, transverse band on anterior margin of each segment. Caudal apicolateral processes without scales, apical third dark brown in contrast to the rest of the abdomen which is yellowish; projecting at about right angles to the longitudinal axis of the body (fig. 10).

Culicoides canithorax HOFFMAN

The reared specimens of *C. canithorax* were collected as larvae or pupae from salt marsh sod samples that were dried in Berlese funnels. Three females and 4 males were reared from larvae to adults; 3 females and 3 males were reared from larvae to pupae, and 3 females and 1 male were reared from pupae to adults (one female with larval skin attached).

DESCRIPTION OF FOURTH INSTAR LARVA. Length about 4.0 mm. Dorsal head length 219 microns; greatest width 160 microns. Head capsule pale yellow with posterior margin delimited by dark brown sclerotized ridge consisting of the hypostomal bridge and the postoccipital ridge. Hypostomal bridge with a non-pigmented mid-ventral light area. Postoccipital ridge wide laterally; dorsally (occipital and postoccipital ridges fused) the pigmented ridge narrow and not readily apparent, a distinct mid-dorsal notch (coronal branch of epicranial suture) present. No longitudinal brown lines present on venter of head capsule (fig. 3). Epipharynx (mola cibarialis of Jobling, 1953) with dorsal comb about 34 microns wide, made up of two halves; proceeding from outermost tooth on each side, there are 4–6 subequal medium size teeth, a larger tooth and 4–6 slightly smaller teeth (fig. 5). Combs 2–4 (see Kettle and Lawson, 1952) present but difficult to distinguish except in dissected specimens. Tips of suspensorial sclerites of hypopharynx about 60 microns apart. Posterior fringe of hypopharynx about 4 microns long.

Thorax distinctly pigmented; dorsally and laterally prothorax with a general mottled purplish coloring except for paler cervical region. Mesothorax similar to prothorax but has, in addition, distinct dorsolateral circular purplish pigmented spots. Metathorax with a lighter general pigmentation, less distinct posteriorly. Dorsolateral spots more elongate than those of mesothorax. Abdomen without dark pigmentation. Anal segment with short, inconspicuous setae, which are shorter than width of anal segment at middle.

DESCRIPTION OF PUPA. Length about 2.6 mm. Pupal respiratory horn about one-fifth dorsal length of abdomen, about 7 times as long as wide; distal section (beyond constriction) less than 2 times longer than basal section. Distal portion with 3 or 4 distinct dorsal projections, each with a spiracular opening; lacking distinct transverse wrinkles, tip with a row of 11–15 spiracular papillae, apical one-fourth dark brownish-black; rest of respiratory organ light brown (fig. 9). Operculum with spines present only behind anteromarginal setae, with row of spines along the lateral margin and others distributed irregularly across the central portion (fig. 7). The two anterior seta-bearing dorsomedian tubercles on each side usually not confluent, lightly pigmented.

Abdomen without fine reticulate lines, with small spines scattered in irregular rows near anterior margins of segments. With elongate seta-bearing tubercles mostly near posterior margins of segments. Abdomen brown with distinct darker brown pattern. This can best be seen in cast skins. The pattern of the developing adult, if present, may obscure the pupal pattern. Dorsally, segment 1 with 2 dorsolateral spots and 1 median spot just behind them; segments 2–7 with a narrow transverse anterior band which tapers laterally, 2 dorsolateral spots just behind it and 2 dorsomedian spots about halfway back; segment 8 with a similar but less distinct pattern which, except for the transverse band, is lacking on the terminal segment. Ventrally, segments 3–9 with pattern similar to corresponding dorsal segments. Caudal apicolateral processes with incon-

spicuous squamous setae, not readily apparent in some specimens; uniformly light yellow; projecting at nearly right angles to the longitudinal axis of the body (fig. 11).

SUMMARY. Collections of annoying adult *Culicoides* on Long Island indicate that *C. melleus* (Coq.) is the most important species in midsummer. DDT emulsion applied at the rate of one pound per acre (technical), or more, greatly reduced larval populations of *C. melleus*. Lower dosages were less effective. The larvae and pupae of *C. melleus* and *C. canithorax* Hoffman, two of the most important pest species on Long Island, are described.

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OBSERVATIONS ON THE SWARMING OF *CULISETA MELANURA* (COQUILLETT)

RICHARD O. HAYES [1]

Details on the swarming habits of most mosquito species are lacking. For a number of species, swarming is thought to be a stimulus for mating and a basic behavior mechanism concerned with the perpetuation of the species. In a discussion of sexual behavior of mosquitoes, Bates (1949) reviewed much of the literature on swarm formation. He pointed out that most of the work done was stimulated by a search for methods which would induce mating in captivity, so that the different species could be maintained as labora-

[1] From the Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education, and Welfare, Taunton, Massachusetts.

tory colonies. Wallis (1953) reported that there was no indication of mating or swarming activity among adult mosquitoes reared from a field-collected egg raft of *Culiseta melanura* (Coquillett); no blood meals were taken by the female mosquitoes, and no eggs were obtained from them. Subsequent workers have experienced similar difficulties in attempting to establish *C. melanura* laboratory colonies.

The utilization of information concerning the swarming of *C. melanura* may facilitate the establishment of self-sustaining laboratory colonies of the species.

Basic information on the phenomenon of swarming conceivably might be exploited for the control of various mosquito species. For example, the effects of aerosol or mist type adult mosquito control measures directed against swarming (and mating) mosquitoes could prove worthwhile. In view of the work on the control of screw-worm through the release of flies sterilized by irradiation (Baumhover *et al.*, 1955), information concerning the swarming and mating habits of a mosquito species might be adapted for similar experiments designed to control mosquitoes (Knipling, 1955).

Methods. The observations on the swarming of *C. melanura* were made as part of studies on eastern equine encephalitis and on the ecology of the potential vectors of this disease. The swarming sites were located at Raynham, Massachusetts, in Hockomock Swamp, a bog-type cedar swamp. Numerous swarms were seen on 13 evenings between June 12 and October 31, 1957, inclusive. The period beginning 1 hour before sunset and continuing until 1 hour after sunset was found to be sufficient for observation of a night's swarming activity. The times of swarm formation and/or of the dispersion of the swarming mosquitoes were recorded each night, except on October 31. On that night, swarming was observed during a brief visit to the swarming area. Specimens were collected intermittently by passing an insect net through the swarms. The times of such collections were recorded, and the specimens obtained were returned to the laboratory to be identified. Examination of male terminalia slides prepared from many of the specimens confirmed the identifications.

Swarms. *C. melanura* swarms were observed as low as 4 feet from the ground and up to heights of approximately 30 feet, but the majority of the swarms occurred between heights of 10 to 20 feet. The swarms characteristically formed beneath the leaves on branch tips of deciduous trees. It was noted that certain swarming sites were always occupied. One such site occurred beneath the leaves of a red maple (*Acer rubrum*) branch tip about 12 feet above the ground. The diameter of the swarms at this swarming site varied between 2 and 3 feet, and their upper perimeter usually remained within 6 inches of the leaves. As the deciduous trees lost their leaves in the autumn, more swarming was noted to occur near and above the Atlantic white cedar (*Chamaecyparis thyoides*).

A compilation of some of the swarming data is presented in Table 1. From an inspection of these data, it is apparent that swarming regularly commenced about sunset and continued for approximately one-half hour. Rain caused the early cessation of swarming on June 12. Very high winds prevented swarm formation on the evening of July 10. The evening of October 27 was windy, clear, and cold (about 35° F.), and no swarms formed; whereas, the evening of October 31 was calm, overcast, and mild (about 45° F.), and swarming occurred.

Female mosquitoes were observed within the swarms, or obtained in collections from the swarms, on only 3 evenings. On one occasion, several mating pairs of mosquitoes were seen. The mating adults remained paired for only 2 or 3 seconds and did not fall out of the swarm, but they did lose altitude. Fertile eggs were laid by a female obtained from the swarm in which the mating pairs were seen.

The number of males in the swarms, which seemed to average several hundred,

TABLE 1.—Swarming time and sky cover observed for *Culiseta melanura* in Massachusetts during 1957.

Date	Commenced		Dispersed		Type of Sky Cover
	Time [a]	Minutes from Sunset	Time	Minutes in Swarm	
June 12	——	——	2022	——	Overcast
20	2026	+1	——	——	Clear
26	2031	+5	——	——	Overcast
July 10	——	——	——	——	Clear
18	2030	+12	2105	35	Clear
25	2011	−1	2050	39	Clear
31	2013	+7	2051	38	Clear
Aug. 8	1954	−2	2026	32	Clear
15	1948	+2	2016	28	Overcast
28	1924	−2	2000	36	Clear
Sept. 4	1912	−2	1955	43	Overcast
19	1845	−3	1915	30	Clear
30	1824	−4	1902	38	Clear
Oct. 27	——	——	——	——	Clear
31	——	——	——	[b]	Overcast

[a] Eastern Daylight Saving Time.
[b] Swarms were present at approximately 1800 hours.

remained rather constant until after the middle of September. The average number of swarming males then became reduced to about a dozen per swarm, and some swarms of only 4 or 5 males were seen.

It was noted that the individuals within a swarm would simultaneously react to sharp sounds, such as a whistle or a shout, by flying several inches away from the sound source. This resulted in a rapid shifting of the swarm. After such a movement, the swarm gradually returned to its original location.

No insects other than *C. melanura* were obtained from the many samples collected from the swarms. Passing a net through the swarms caused only momentary disturbances, and the swarming was continued persistently.

Gentle winds did not interfere with swarming. Swarms formed and continued uninterrupted on evenings with either clear or overcast skies.

DISCUSSION. Evening swarming of *C. melanura* in the vicinity of their breeding area was observed to be a very routine phenomenon which commenced about the time of sunset. Their swarming beneath branches and their repeated use of certain swarming locations resembled swarm characteristics previously described for *Aedes punctor* by Frohne and Frohne (1952). However, the *A. punctor* swarms were reported (*loc. cit.*) to terminate, rather than to commence, about the time of sunset.

The formation of swarms at the time of sunset, generally within ±5 minutes, seems to correlate this activity with light intensity. Swarming commenced at about sunset whether the sky was clear or overcast. Other investigators (*e.g.,* Nielsen and Greve, 1950; Frohne, 1953; and Bates, 1949) have thought light intensity to be the principal stimulus for swarm formation.

The exact time of swarm dispersion was harder to ascertain than the time of swarm formation. As it became darker, it became more difficult to see whether or not a few of the mosquitoes were still swarming.

Mating mosquitoes were rarely seen in the swarms. Additional observations will be necessary to determine whether or not swarms are the principal mating sites.

Culiseta incidens is believed to be the only North American representative of the genus for which mating swarms (Hubert, 1953) have been described. Mating in swarms has not been observed among the other known North American species, namely: *C. alaskaensis* (Frohne, 1954), *C. impatiens* (Frohne, 1953), *C. inornata* (Rees and Onishi, 1951), *C. macrackenae* (Ryckman and Arakawa, 1952), and *C. morsitans* (Frohne, 1954). No mating observations have been reported for the recently described *Culiseta minnesotae* (Barr, 1957).

The usual *C. melanura* adult emergence period in the Hockomock Swamp swarming area probably is from late May to mid-October, similar to the emergence period described for the species in New Jersey (Burbutis and Lake, 1956). However, adult emergence during August and September 1957 virtually ceased in the Hockomock Swamp, because of an unusually severe drought which resulted in the drying of the usual breeding sites. The presence of large numbers of males in the swarms during September and October was particularly interesting, since it indicated that the majority of the males observed during these months had survived at least 3 months.

Summary. Evening swarms of *Culiseta melanura,* predominantly males, were observed on 13 nights between June and October 1957 in southeastern Massachusetts. It was noted that the swarms occurred regularly starting at about sunset near the mosquito breeding sites in a large swamp, that swarms usually formed beneath the foliage on branch tips, and that particular swarming sites were always occupied. Mating was observed in the swarms occasionally.

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AEROSOL TESTS WITH DDT AND MALATHION COMPARING FIVE SPECIES OF MOSQUITOES AND COMPARING SALT-MARSH *AEDES* FROM EIGHT LOCALITIES IN FLORIDA AND GEORGIA

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Deonier and Gilbert first reported DDT resistance in salt-marsh *Aedes* in Florida in Brevard County in 1950 (Deonier and Gilbert, 1950). McWilliams and Munn (1957) more recently reported evidence of DDT resistance in salt-marsh *Aedes* at Key West. Following the report by Rogers *et al.* (1957a) of poor results with DDT in aerosol dosage tests against adult *Aedes taeniorhynchus* (Weid.) from Indian River County, the question was raised as to the possible difference in susceptibility of this species to DDT in thermal aerosols in other areas of the state, especially in counties where DDT had been used for only a few years. Consequently, in the spring of 1957 a study was initiated to demonstrate the difference in kill, if any, that might be obtained with DDT between *Aedes taeniorhynchus* adults from several areas of Florida and Georgia. Comparable tests with malathion were also conducted for comparison.

Eight areas were selected, three on the east coast and three on the west coast of Florida, plus the Florida Keys (Monroe County) and Savannah (Chatham County), Georgia. The Florida east coast areas were Dade, Indian River and St. Johns counties; the west coast areas were Lee, Sarasota and Citrus counties (see Figure 1).

In conjunction with the area studies it seemed desirable also to compare the effectiveness of DDT and malathion against several species of mosquitoes. For these tests adults of five species were used: *Aedes taeniorhynchus* (Weid.), *Aedes aegypti* (L.), *Psorophora confinnis* (Lynch-Arr.), *Culex quinquefasciatus* Say and *Anopheles quadrimaculatus* Say, plus limited studies with *Aedes sollicitans* (Walker), and *Psorophora ciliata* (Fab.).

METHODS: TEST INSECTS—The mosquitoes for the area study were collected by two methods. Originally salt-marsh sod was tested in the field for viable *A. taeniorhynchus* eggs. When productive sod was found, it was cut and transported to the Entomological Research Center at Vero Beach. In the laboratory the sods were flooded to hatch the eggs and the larvae were reared to the adult stage under identical conditions of food, temperature, light, etc. according to procedures previously described (Rogers *et al.*, 1957b). However, due to the uncertainty of obtaining sods with good numbers of viable eggs, and the problems in cutting and transporting the sods, a second method (developed by J. S. Haeger of the Entomological Research Center) was used for most of the area studies. This method consisted of collecting adult *A. taeniorhynchus* in the field, and transporting them in special jars to the laboratory where they were given blood meals. The eggs from these adults were flooded and the larvae reared in the same manner as from sods.

The mosquitoes in the species study were, however, either collected as larvae or pupae in the field or reared from laboratory colonies. TESTING—The tests were conducted in early evening hours on a level, open area with no trees or heavy underbrush to block the travel of the fog, thus allowing maximum conditions for coverage. Two cages of mosquitoes were attached to a stake (see Figure 2), one at the six-foot level and the other at two feet from the ground, similar to methods pre-

viously described (Rogers *et al.*, 1957b). The stakes were placed at intervals of 165, 330 and 660 feet, perpendicular to and downwind from the line of travel of the fogging vehicle. Each test or replicate consisted of the cages from two sets of stakes placed a block apart, a total of 12 cages. In all tests, caged *A. taeniorhynchus* from Indian River County were hung on stakes side by side with caged mosquitoes from the other areas or species under comparison (see Figure 2).

In some instances two or even three areas and/or species were compared in the same test with *A. taeniorhynchus* from Indian River County. Thus, there were as many as four stakes at each station in some tests, with each stake supporting caged adult mosquitoes from a different area.

It was felt that the inclusion of *A. taeniorhynchus* from Indian River County in all comparative tests was desirable since there are known differences in mortality due to weather factors and minor opera-

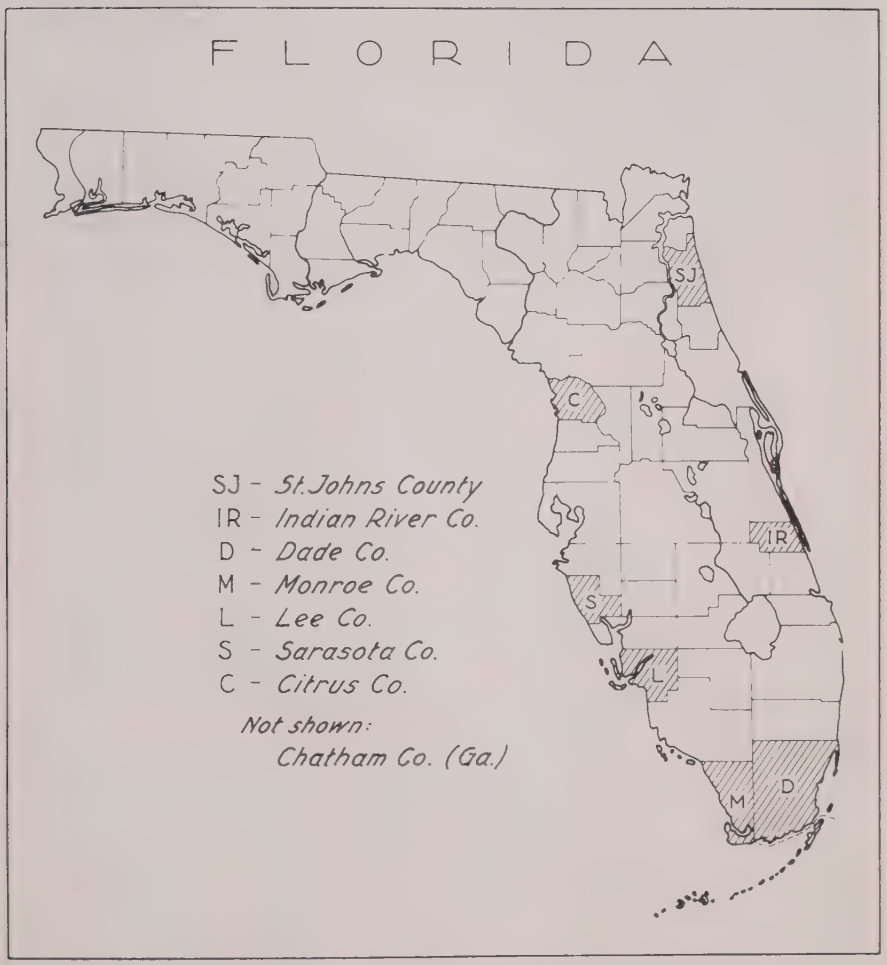

Fig. 1.—Counties studied in the area-comparative tests against *Aedes taeniorhynchus*.

FIG. 2.—Stakes with cages attached as used in comparative tests. Cages on one stake contain *Aedes taeniorhynchus* from Indian River County; cages on the other stake hold mosquitoes to be compared.

tional differences. Thus, by including *A. taeniorhynchus* from Indian River County as a standard in all tests, it would be possible to show differences between certain areas or species.

A Jeep-mounted Tifa aerosol generator calibrated to deliver 40 gallons per hour at 1000° F. operating temperature, 25 p.s.i. formulation pressure, and driven at five miles per hour was used in all tests. Machine operations were checked constantly during tests and insecticides were measured before and after each test.

In all comparative tests, DDT was used at the rate of 10 ounces of technical DDT per gallon and malathion at 8 ounces per gallon of No. 2 diesel oil. According to the space method of calculating dosage (Rogers *et al.*, 1957a), DDT was used at approximately 0.37 lb. per acre and malathion at approximately 0.30 lb. per acre over a swath of 330 feet.

After treatment, the mosquitoes were changed into clean cages and held in a shed for 12 hours, then counted to determine mortality. Only female mosquitoes were used in determining per cent mortality. All mosquitoes used in the tests were between two and eight days old at the time of testing, and had been fed only sugar water.

RESULTS. Average kills for malathion in Tables 1 and 2 represent two replications and the DDT averages are from four replications, except where noted in the tables.

An analysis of variance, using the arcsine transformation of percentages, showed no significant differences in susceptibility to DDT between *A. taeniorhynchus* from St. Johns, Lee and Sarasota counties when compared to specimens from Indian River County. However, significantly higher kills were obtained with DDT against *A. taeniorhynchus* from Dade and Monroe (Key Largo) counties and from Chatham

County (Savannah) Georgia than against *A. taeniorhynchus* from Indian River County. In a limited number of tests with DDT against mosquitoes from Citrus County there appeared to be no difference in kill when compared to mosquitoes from Indian River County.

There appeared to be no differences in susceptibility of *A. taeniorhynchus* to malathion from any of the areas tested when compared to Indian River County specimens (see Table 1).

In the species study, considerably better kills were obtained with DDT against *A. aegypti, A. quadrimaculatus,* and *P. confinnis* than with *A. taeniorhynchus* or *C. quinquefasciatus.* In a limited study with DDT against *P. ciliata* there also appeared to be a difference in kill when compared to *A. taeniorhynchus.*

The kills with malathion against different species were much more uniform than with DDT (See Table 2).

In the area-comparative tests, *Aedes sollicitans* comprised seven percent of the 3824 salt-marsh *Aedes* used from all areas in the malathion replications. The overall kill (660′ swath) of *A. sollicitans* in the malathion tests was 81 percent. Six percent of the 2630 specimens within the 330-

TABLE 1.—Results with malathion and DDT comparing *Aedes taeniorhynchus* from eight geographical areas

Mosquito Origin County	Percent Kill at Indicated Swath in Feet						No. Years DDT Used Prior to Tests
	Malathion		DDT				
	330 Feet	660 Feet	330 Feet			660 Feet	
	Average	Average	Average	Range	lsd at 5% [1]	Average	
Monroe	55	47	29	19–37	6	20	6 [2]
Indian River	62	56	12	5–20		9	
Dade	85	79	29	17–58	1	20	13
Indian River	83	79	13	0–44		12	
Indian River	93	88	9	2–16	N.S.	7	11
Indian River	93	90	12	6–16		8	
St. Johns	85	76	11	3–24	N.S.	8	11
Indian River	93	83	13	5–27		10	
Lee	95	89	18	11–33	N.S.	14	11
Indian River	98	93	14	4–30		11	
Sarasota	83	73	11	1–26	N.S.	8	12
Indian River	77	70	7	2–14		6	
Citrus [3]	100	97	74	——	——	62	4
Indian River [3]	100	100	69	——		62	
Chatham (Ga.)	94	88	24	10–39	5	18	5
Indian River	85	80	6	0–10		5	

[1] Significant differences calculated only for DDT in 330′ Swaths.
[2] Key Largo only: DDT used 10 years in "lower keys," i.e. Big Pine Key to Key West.
[3] Only one replication with malathion and one with DDT.

foot swath in these tests were *A. sollicitans* and the kill at this swath was 88 percent.

A. sollicitans comprised six percent of 8337 salt-marsh *Aedes* from all areas in the comparative tests using DDT, and the overall kill (660′ swath) was 24 percent. Of 5929 specimens included in the 330-foot swath of these tests, *A. sollicitans* also comprised six percent, and the mortality with DDT at this swath for *A. sollicitans* was 30 percent.

Considering *A. taeniorhynchus* only from Indian River County in the area-comparative tests, the kill of this species in all of these tests using malathion averaged 92 percent at 330 feet and 87 percent at 660 feet. Comparable kills against *A. taeniorhynchus* with DDT in these tests were 28 percent at 330 feet and 26 percent at 660 feet.

DISCUSSION. It is felt that the low kills obtained with malathion in the Monroe vs. Indian River tests (Table 1) and in the *A. aegypti* vs. *A. taeniorhynchus* tests (Table 2) were the result of low temperatures. The temperatures at the time these tests were run were between 50 and 53° F., a temperature of approximately 50° F. being known to be the threshold of activity for *A. taeniorhynchus*. However, the low kill obtained with malathion against *P. ciliata* (Table 2) cannot be attributed to any observed factors.

The closeness of the percentage kills obtained in the comparative test of Indian River County vs. Indian River County in Table 1, or the *A. taeniorhynchus* vs. *A. taeniorhynchus* in Table 2, gives a good indication of the reliability of the tests. It appears from these data that the reproducibility of results is excellent when conducted under identical conditions of weather and machine operation. Thus, the greater differences appearing between *A. taeniorhynchus* or Indian River County results in different tests apparently is an indication of the effect of the variability of weather and operational factors when using a marginal material such as DDT against *A. taeniorhynchus* in Florida.

There is also a highly significant correlation ($r = 0.79$ for 9 df) between the percent kill obtained with DDT and that obtained with malathion when tests with

TABLE 2.—Results of tests with malathion and DDT comparing six species of mosquitoes

	Percent Kill at Indicated Swath in Feet				
	Malathion		DDT		
	330 Feet	660 Feet	330 Feet		660 Feet
Species	Average	Average	Average	Range	Average
A. taeniorhynchus	93	88	9	2–16	7
A. taeniorhynchus	93	90	12	6–16	8
A. aegypti	83	78	79	68–97	74
A. taeniorhynchus	65	55	44	6–83	34
P. confinnis [1]	100	94	61	47–74	49
A. taeniorhynchus [1]	100	96	30	15–41	22
P. ciliata [2]	65	56	81	———	77
A. taeniorhynchus [2]	88	77	5	———	3
C. quinquefasciatus	84	82	21	4–57	15
A. taeniorhynchus	90	87	31	5–83	25
A. quadrimaculatus [3]	92	81	89	80–99	83
A. taeniorhynchus [3]	91	85	33	5–60	22

[1] Only one replication with malathion.
[2] Only one replication with malathion and one with DDT.
[3] The 660′ average kill with DDT based on 3 replications.

both insecticides were conducted on the same night. This may indicate the influence of some optimum or poor fogging conditions. As yet no definite statements can be made as to the singular effects and interactions of wind, temperature, inversion, relative humidity and other factors. However, a study of this nature is being conducted, which, it is hoped, will result in a better understanding of this complex problem.

The data in Tables 1 and 2 only serve to demonstrate the differences or lack of differences that occured between mosquitoes from different areas and between different species in these tests, and it is not intended to imply that these same percent kills could be expected under different conditions of terrain, weather, equipment, etc.

By taking all tests into consideration, a definitely better kill was obtained with malathion than with DDT, even though the amount of DDT applied was considerably higher than that usually applied in control operations. It is also known that, at the dosage used, malathion is slightly sublethal to *A. taeniorhynchus* in these tests. However, this dosage was used in order to demonstrate any differences in kill that might occur with malathion between *A. taeniorhynchus* from different areas and between different species.

Data from comparable tests conducted in different years with DDT and malathion against *A. taeniorhynchus,* shown in Table 3, not only confirm the accuracy of the testing methods, but also show conclusively that DDT is not effective as a thermal aerosol against *A. taeniorhynchus* in Florida at the present time.

Widely varying factors associated with the use of chlorinated hydrocarbons in different areas studied, such as size of treated areas, number of yearly insecticide applications, dosage, etc., make a quantitative comparison of the study areas on the basis of DDT usage impractical, if not impossible. Therefore, the best available basis for attempting such a comparison seems to be in the number of years that DDT and/or other chlorinated hydrocarbons were used as the principal insecticides in each area. These records, kindly supplied by the district mosquito control directors, are shown in Table 1.

On the basis of this comparison, further supported by more detailed information not included here, it is concluded that the best kills against *A. taeniorhynchus* in these tests were not consistently associated with areas having the shortest history of DDT usage. Space will not permit a detailed area-by-area discussion of this point. The important conclusion, relating to the original objective of the research, is that at the present time DDT even in massive dosages is not an effective adulticide against *A. taeniorhynchus* in Florida, when applied as a thermal aerosol. If it is assumed that this condition is due to "acquired resistance," then it appears very doubtful that

TABLE 3.—Results of tests against *Aedes taeniorhynchus* from Indian River County with malathion and DDT in 1956 and 1957

Insecticide	Dosage [1] lb./acre	Formulation lb./gal.	Year	Replications	Percent kill at Indicated Swath 330 Feet	660 Feet
Malathion	0.30	0.5	1956	18	90	88
			1957	19	91	86
DDT	0.37	0.625	1957	33	28	26
	0.60	1.0	1956	5	41	30
			1957	2	33	25
	1.19	2.0	1956	1	11	7
			1957	3	36	27

[1] Calculated on assumed average wind velocity of 3 m.p.h. (Rogers *et al.*, 1957a.)

there are at present any areas in the state which can properly be classified as "non-resistant." It can also be concluded that the degree of tolerance by this species to DDT is not the same in all areas of the state, and that the reasons for this are not known to the authors.

The widely varying results with DDT against different species, as shown in Table 2, also present a difficult problem of interpretation. While it is true that the highest kills were obtained with *Anopheles quadrimaculatus* and *Aedes aegypti* secured from laboratory colonies, the variable results obtained with DDT against the other species, all collected from natural breeding areas, do suggest that the natural tolerance of a species to DDT should be considered. However, the malathion data do not indicate a wide difference in susceptibility to this insecticide among the species studied.

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REPLY TO REQUEST FOR INFORMATION

Editor: In the *Mosquito News* just received, I note a query from Bob Armstrong about how to recover dusts to measure recovery at distances from the emitting machine. At Ft. Belvoir we used 6 x 6 in. glass plates coated with oil. These plates were recovered and the captured material (DDT) was analyzed quantitatively, using Dr. Haller's method, which was a relatively simple one after it was set up. I do not know if they continued this after I left or devised a better way. Perhaps members Carl Wesley or Lafe Edmunds could tell you. We tried laying the plates horizontally and hanging them up vertically and decided that our recovery was adequate either way. This measures the amount actually reaching the ground or passing through the foliage. I'd suggest a note to Carl or Dr. Edmunds might bring a response of interest since they've been at it over two years since I left and no doubt have added a lot to my primitive techniques.—(Signed) AUSTIN MORRILL, JR.

DIELDRIN FORMULATIONS ON MUD WALLS IN MEXICO

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In the worldwide malaria eradication programs, the usual method of attack is the application of a residual insecticide to the interior surfaces of the homes. In many areas, mud is the predominant building material. Recently in several countries where malaria eradication campaigns are under way, it has been reported that when the insecticides are applied to mud walled houses, sometimes the effectiveness of the insecticide is lost at a very rapid rate. It is believed that this phenomenon may be due in part to the adsorption of the insecticide on the mud walls. If this adsorption problem proves to be serious and if it becomes widespread it could seriously affect the malaria eradication programs unless some means are found to prevent this reaction.

In 1956 the Pan American Sanitary Bureau, the Mexican Government and the Shell Companies joined in a project known as the Dieldrin Study Project with the purpose of evaluating dieldrin as an insecticide for use in malaria eradication programs, particularly on mud walls. The study was to be made in Mexico in conjunction with their National Malaria Eradication Program which was getting under way, and where most of the homes in the rural area are made of mud; bricks, blocks or plaster.

The chief objectives of the study are:

(a) To evaluate the biological effectiveness of test pesticides against the important vectors of malaria under various climatic conditions in different areas.

(b) To determine the susceptibility levels of the malaria vectors to test pesticides.

There are other objectives but the two given above are the major ones and will be the ones discussed in this paper.

Three areas were selected in which to conduct these studies. They contained a total of 20 villages, most of them small, as we preferred villages of approximately 200 homes. In selecting an area, there are several criteria which had to be met such as: unsprayed area, many small villages to select from, plenty of mosquitoes, home owners willing to allow their homes to be used, a high percentage of the homes constructed of mud, all-weather roads, fair accessibility from headquarters, an area where a government malaria eradication project was operating, a town where the personnel could live, and each area had to be in a different geographical zone. The three areas selected were: Acapulco, where studies are conducted in eight villages; Oaxaca, where five villages are in use; and Puebla, where seven villages are in the tests.

Acapulco is on the west coast, an area where malaria is well known and where the two chief Mexican malaria vectors (*Anopheles albimanus* and *Anopheles pseudopunctipennis*) are found. Oaxaca is located in the southern part of Mexico and is a state that has been noted for its high malarial rate. The chief malaria vector here (Oaxaca) is *A. pseudopunctipennis* which breeds in the streams so common in this section. Grassy pools, roadside ditches, and some irrigated fields also produce this mosquito in fairly large numbers. Puebla is located in the central section of the country at an elevation of approximately 7,000 feet above sea level. This is an extensively irrigated rice and cane growing area. This results in a large population of *A. pseudopunctipennis*.

The majority of the houses in the small villages where we work are made of mud and most of them are about the same size. Along the coast, where it is warm, sticks and canes are often used to make a frame over which the mud is plastered, while in

the areas of greater altitude, mud or adobe brick are used to build the home and mud plaster may or may not be applied. Most of the homes are of one room; if two rooms are needed a second room with a separate roof is built. If the roof is of grass, and many of them are, it is built on the ground and then lifted to the top of the walls. This tends to limit the size of the houses which probably average 10 feet wide and 16 feet long. Most of the cooking is done outside or in a small shed attached to the main room.

In making the experiments to determine the lasting qualities of the test insecticide, dieldrin was applied at the rate of 25, 50 and 100 mg. per sq. ft. to the interior walls of the homes as a residual spray. Each village was sprayed at one application rate, and the test was repeated in each of the three areas. An exception was that a few houses were selected for special tests such as using different rates of application on separate walls and/or using special types of mud on the separate walls and then treating all walls at the same application rate. In these villages are found many types of soil and even within a village or within a house adobe of several colors can be found. Samples of these different building muds were taken from the villages in the test areas and sent to the Shell Chemical Corp. where chemical and biological tests were made of each type of mud.

We obtained some of our dieldrin from the Mexican Malaria Eradication Commission and in the tests this dieldrin is called Regular Dieldrin in order to distinguish it from a special formulation of dieldrin supplied to us by the Shell Chemical Corp. which is classed as Experimental Dieldrin. This Experimental Dieldrin was made specially for use on mud walls that are deactivating to residual insecticides. We received shipments from several "batches" of this experimental dieldrin, and they differ from Regular Dieldrin mainly by having been treated by special resins. This Experimental Dieldrin is composed of 50 percent dieldrin, 25 percent resin, plus regular wetting agents and inerts. We also have the 75 percent water wettable dieldrin under test.

The first application of insecticide in our tests was applied on October 4, 1956. Three villages were treated at this time, two villages with dieldrin using 25 mg. per sq. ft. and one village with DDT using 200 mg. per sq. ft. In one of the villages Experimental Dieldrin No. 232 was used and in the other village Regular Dieldrin was used. The 25 mg. rate of application is approximately 40 percent of the WHO recommended rate, and was used in order to reach the "breaking-point" of effectiveness of the insecticides quickly. The last of the 20 villages were sprayed in May of 1957. There are at present in the experiment three villages treated with DDT at 200 mg. per sq. ft. and 17 villages treated with Dieldrin (Experimental and Regular) at rates from 25 mg. to 100 mg. per sq. ft.

All of the villages used in the study were sprayed by the Malaria Eradication Teams of the National Government. A typical spraying was sought, the type that was being done nation-wide and we believe that a representative spraying was obtained. We weighed the insecticide, enough in a paper bag to charge one spray can, and delivered it to the foreman in the village to be sprayed. A different colored bag was used in each village and thus we could prevent the wrong material or a different amount from being used in a village where it was not intended for use.

In evaluating the results of these tests we used five methods which are as follows:

1. Wall Tests.
2. House Inspection.
3. Larval Inspection.
4. Trapping or releasing of mosquitoes in sprayed houses.
5. Chemical analyses made of samples from the walls of sprayed houses.

In the wall tests the mosquitoes are confined in petri dishes, 15 in each dish, and held against the wall for one hour. The final readings are made 24 hours after being removed from the wall.

The mosquitoes used in the wall tests are collected locally, are held overnight and the strongest specimens used the next morning. The mosquitoes are carried to the field in small cages and are removed with a suction tube and placed in a petri dish that has a bristol board cover. This petri dish is placed against the wall with the bristol board against the wall and the paper is then removed. The petri dish is fastened to the wall using either tape or pins and rubber bands. Thus the mosquitoes are caged against the treated surface, the petri dish confining them to the area selected. After an exposure period of one hour the bristol board is slipped back under the petri dish and the mosquitoes are removed and released in a holding cage where they are kept for 24 hours at which time the mortality is determined. Controls are given the same handling except that they are exposed to untreated surfaces —we seldom have any specimens die in the controls as great care is taken to prevent insecticide contamination and the mosquitoes are carefully handled.

In the house inspection, 15 houses in each village are inspected for 20 man-minutes twice a month. If mosquitoes are found in sizable numbers they are held in cages for 48 hours to determine if they have received a lethal exposure to the insecticide. Larval inspections are conducted in mosquito breeding places located within or adjacent to the sprayed village. Ten stations were selected and 100 dips are made in each station per month. The larvae are recorded as to species, number and size. Traps were placed in a few vacant houses (we rented these houses and had the people move) and mosquitoes are allowed to enter or are released and are captured later in door traps or found dead on the paper-covered floor. It required a large mosquito population to conduct this type of experiment and we feel that we did not have enough mosquitoes to receive the maximum benefits from these houses.

Wall scrapings and cellulose tape samples were taken from the sprayed walls, the first samples being taken one hour after spraying and at regular intervals thereafter. These samples were sent to the Shell Chemical Laboratories in Denver where chemical analyses were made. The chemical analyses showed that the spraying was very uniform. Five samples taken one hour after spraying in a room showed little variation; however, samples taken at monthly intervals showed a greater percentage of loss in the insecticide by chemical analyses than by biological tests. Often the chemical analyses show no insecticide while the biological tests produced a very good kill.

The first villages which were sprayed in October 1956 using 25 mg. of dieldrin per sq. ft. showed, as the insecticide aged, a very slow decline in the percentage of mortality by wall tests and also the number of mosquitoes found at inspection slowly increased until 335 days after spraying when some of the tests were giving a percentage of mortality as low as 29 percent, others were as high as 77 percent. We had set a 40 percent mortality by wall tests, as the percentage to be reached when we would declare that the insecticide had lost enough of its effectiveness that respraying should be done.

This is based on the fact that a female mosquito must visit a house two or more times and probably rest on the treated walls three or more times in order to take blood from one person and then 10 or more days later return to a treated house and bite a person. If 40 percent of the mosquitoes are killed each time they rest on the treated wall, by the time the third resting period has passed there will be few if any mosquitoes alive. No consideration is taken of natural death during the 10-day period or of the fact that the mosquitoes will feed several times during the 10-day interval following the first feeding and thus may enter and rest on the wall many times more than the three times that we consider when determining the effectiveness of the residual spray.

Using this criterion we received satisfactory mosquito mortality for over 300

days with the 25 mg. rate of application applied to mud surfaces. In fact, in a few houses the insecticide was active (65 percent kill) at 386 days. The tests were discontinued after 335 days and the villages were returned to the National Malaria Eradication Commission for inclusion in their annual spraying campaign.

There are four other villages in the test sprayed at the 25 mg. rate using either the Experimental Dieldrin or the Regular Dieldrin. However, these villages were sprayed in April of 1957 and are now approaching the 300th day since spraying and the data indicated that satisfactory mortality (40 percent or above) will be obtained for over 300 days.

In the experiment there are nine villages treated with either Experimental Dieldrin or Regular Dieldrin at the rate of 50 mg. per sq. ft. These villages have been treated for less than 300 days and it appears that it will be 50 to 100 days more before observations are terminated. Four of these villages are in the Acapulco area and these villages are showing a rapid loss in the effectiveness of the residual insecticide, and the data indicate that satisfactory results may not be obtained over a longer period of time than that received from the 25 mg. rate. The above is not true in either the Puebla area or the Oaxaca area where somewhat better results are being obtained with the heavier application than with the 25 mg. rate.

There are several tests under way in which each wall of the house is treated at a different application rate (25, 50, 75 and 100 mg. per sq. ft.). This type of experiment gives us data on the four rates under the same conditions. There is a series of houses in a test where a different type of soil (adobe) is used on each wall of a house and all walls are then sprayed alike. In another experiment a group of houses are used in which the same type of mud is used in all houses, but two walls in each house have the mud plaster finished very smoothly, while the other two walls are left with a very rough finish. All of the walls are sprayed with the same material and at the same rate. These rough and smooth walls have been treated for less than 200 days and at present there is no difference in the killing effect of the insecticide on either wall. Observations will be continued.

The data from these village-wide tests that have been completed, show that the Experimental Dieldrin and the Regular Dieldrin gave satisfactory mortality of mosquitoes when applied at the rate of 25 mg. or more per sq. ft. to mud walls for 300 or more days, and that longer effectiveness is obtained with the heavier dosages but not in the same ratio as the application rate.

The mud used in home construction in the Puebla area and the Oaxaca area shows no deactivating qualities towards the insecticides used. However, in the Acapulco area there is a deposit of yellow mud that is used to plaster some of the homes and tests made in houses plastered with this mud gave a low percent of mortality, by wall tests, at the end of 60 days. After 120 days the percent of mortality based on "wall tests" increased and at the end of 250 days after spraying the insecticides are producing satisfactory kills. We cannot explain why the percent of mortality was low at 60 days and later showed an increase in effectiveness. Additional tests are under way in this area using houses treated with the yellow adobe. There is also found a red mud in this same area that is used in house construction. The earlier tests indicate that the effectiveness of the insecticides was reduced by 15 to 20 percent when applied to this Red Acapulco Mud. We have several tests now under way to determine if it is the mud that causes the reduction in effectiveness or some outside factor such as dust, smoke or housekeeping methods.

The World Health Organization's kit for testing susceptibility of mosquitoes to insecticides was used in the Puebla and Acapulco areas to determine the susceptibility level of the species of mosquitoes that we are working with. We used DDT and dieldrin impregnated papers at the

recommended concentrations with *A. albimanus* and *A. pseudopunctipennis*. These tests are to be repeated every six months and a comparison made of the data collected at each testing to see if the susceptibility of the species that we are working with changes during the time that we are making the study. At present we have only the first readings; other readings will be made at 6-month intervals.

In the tests made to date we found that *A. albimanus* and *A. pseudopunctipennis* were very susceptible to both insecticides to about the same degree; however, *A. albimanus* did show a slight bit more susceptibility to the test materials.

CONCLUSIONS. Tests were made in Mexico to determine the lasting qualities of several formulations of dieldrin and also of DDT when applied as a residual insecticide in malaria eradication work. It was found from tests made in three areas in Mexico that the insecticides when applied to mud surfaces gave over 300 days of effectiveness using 25 mg. of dieldrin per sq. ft. in two of the three areas and slightly less in the third area. Higher application rates, 50 mg. to 100 mg. of dieldrin per sq. ft., gave a longer lasting period of effectiveness but not in the same ratio as the quantity of insecticide used. Tests are still under way in the area where the red mud gave a shorter period of effectiveness.

Tests made to date using the World Health Organization's kit for testing the susceptibility of mosquitoes to insecticides showed that the *Anopheles* in the areas where we are working are very susceptible to dieldrin and DDT.

A SAMPLING PROCEDURE FOR *CULICOIDES MELLEUS* (COQ.) (DIPTERA: HELEIDAE) WITH OBSERVATIONS ON THE LIFE HISTORIES OF TWO COASTAL *CULICOIDES* [1]

HUGO JAMNBACK [2] AND WILLIAM J. WALL [3]

Culicoides melleus (COQ.). The unusual breeding habitat of *Culicoides melleus* (Coq.), sandy beaches along the coastline, was apparently first recorded by Goulding *et al.* (1953) in Florida. On Long Island, N. Y., small numbers of *Culicoides melleus* larvae were collected from samples of intertidal sand examined under a wide-field dissecting microscope. The larval sampling methods described by Dove *et al.* (1932), Carpenter (1951), Kettle and Lawson (1952) and Wirth (1952) were tried with only limited success.

LARVAL SAMPLING. In the spring of 1957, a more useful method of sampling was developed after observing the behavior of *C. melleus* larvae in the laboratory. Larvae placed in a 50 ml. graduate containing about 10 ml. of sand and 30 ml. of water stayed beneath the surface of the sand. When the graduate was inverted and returned to an upright position the sand settled in a few seconds and the larvae could be seen swimming in the water. A few swam upward for a short time before sinking slowly to the bottom but most swam downward. In less than two minutes almost all of the larvae disappeared again beneath the sand. These

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observations indicated that the larvae were readily dislodged but that they re-enter the sand a short time after being dislodged. After testing several variations in sampling technique, a "standardized" sampling procedure which took these observations into account was developed. This procedure is as follows:

1. One-third pint samples of sand are collected from suspected breeding areas. A jelly glass of one-third pint capacity is a convenient collecting and measuring container.

2. In the laboratory, the sand is placed in a pint jar and an equal amount of tap water is added.

3. The water is decanted into another pint jar and then poured quickly back into the jar containing sand so that it mixes with it. This process is repeated six times.

4. After the sixth time the sand is allowed to settle for 2–3 seconds, then the water is decanted into a jar without sand.

5. A portion of this water, the amount depending on the turbidity, is then poured into a cylindrical jar and held over a light bulb shielded with white bond paper.

6. *C. melleus* larvae, if present, can be seen clearly from above swimming in the water, which is gently swirled every few seconds. The larvae are removed with a medicine dropper. All of the water in the sample is examined in this way.

7. The entire procedure is then repeated with the same sample and the total number of larvae obtained from two subsamplings is recorded.

8. If more than 50 larvae are present in a one-third pint sample it is recorded as 50+; otherwise all of the larvae are counted.

This technique proved to be satisfactory in estimating *C. melleus* larval populations, but is not directly applicable for use in sampling populations of species breeding in muddy habitats where the water becomes too turbid to see the larvae.*

Some of the larvae present in a given sample of sand remained in the sand after mixing with water and therefore were not counted. The proportion of those present in a given sample which are actually counted was estimated in the following way. Four one-third pint samples of sand were thoroughly dried. They were then flooded and examined to make sure no larvae were present. Next, 100 *C. melleus* larvae were distributed uniformly in each of the samples. The sampling procedure outlined above was followed. The numbers of larvae collected are shown in Table 1.

The data presented in Table 1 indicate that about two-thirds of the larvae in a given sample are collected by the use of the *C. melleus* sampling procedure described above.

DISTRIBUTION OF LARVAE. The number of *C. melleus* larvae collected from intertidal sand in different localities varied greatly, apparently depending on a combination of factors. Within a given area, i.e., along a particular beach, if present, they occurred in a band between high and low tides. Usually they were not present near the high or low tide marks, except for an occasional larva. The width of the band where the larvae were most numerous varied from beach to beach, apparently depending on the slope and tidal range. Along most of the Long Island beaches it was less than 20 feet wide. The more gradual the slope and the higher the tide, the wider the band where larvae occurred. Another important factor seems to be the exposure of the beach to waves. Larvae were usually found in protected bays or inlets, but were scarce or altogether absent along beaches which are exposed to prolonged and heavy wave action.

VERTICAL DISTRIBUTION OF LARVAE. Laboratory observations indicate that the larvae live close to the surface. When large numbers of larvae were placed in

* Bidlingmayer (1957) recently described a somewhat similar technique for sampling larval populations of *C. furens* (Poey). Since the larvae of this species are found in muddy situations, sand is poured over the mud sample. It is then flooded and allowed to stand over night. A high proportion of the larvae migrate into the sand where they can be removed more readily than from mud.

TABLE 1.—The effectiveness of the *C. melleus* sampling procedure.

Replicate	Numbers of Larvae Collected			Number of Larvae Present
	1st Sub-Sample	2nd Sub-Sample	Combined Total	
a	48	20	68	100
b	44	18	62	100
c	51	21	72	100
d	40	19	59	100

jars of sand covered with a little bay water some could be seen, with a binocular dissecting microscope, gliding just beneath the surface of the sand, at a depth of 1 to 3 grains of sand. If they were not disturbed, some would partially emerge from the sand and remain with their bodies perpendicular to the surface for several minutes. Occasionally one could be seen apparently ingesting minute particles. The sweeping action of the epipharynx as they swallowed could be observed readily. When the jar was tapped the larvae quickly disappeared into the sand but after a few seconds they would suddenly reappear.

Four vertical distribution samples were taken to see if the larvae occurred mostly near the surface under natural conditions. Two of the samples were taken in April and two in July. A total of 121 *C. melleus* larvae were collected in these samples. Of these, 105 were found in the top one-half inch, 16 in the next one-half inch and none in the next 3 inches. There appeared to be no difference in the vertical distribution of larvae collected in April and July. All four samples were taken at about low tide during the daylight hours.

Larval Abundance and Growth. *C. melleus* larvae were abundant during the entire sampling period from March through August. Larvae 1.8 mm. in length or longer were found every month from March through August. The average length of larvae (calculated on a monthly basis increased gradually from 2.5 mm. to 3.3 mm. from March to June. In July and August it decreased to 2.2 mm. and 2.7 mm. respectively, due to the appearance of small larvae. The smallest larvae collected were 1.5 mm. long. These were consistently present in July and August collections but were not found earlier in the season.

Pupae. In 1957, the first *C. melleus* pupation noted took place in the laboratory. The larva had been collected on April 8 and pupated on May 3. The first pupa found in the field was collected on May 11. Table 2 shows the seasonal changes in relative abundance of *C. melleus* larvae and pupae collected in 1957.

TABLE 2.—The relative abundance of *C. melleus* larvae and pupae collected on Long Island in 1957

Period	Number of Larvae	No. of Pupae per 100 Larvae
March	105	0
April	256	0
May 1–15	759	0.9
May 16–31	232	1.3
June 1–15	667	2.6
June 16–30	1347	6.8
July 1–15	258	2.7
July 16–31	1025	0.7
August	1009	0.3
Total number collected	5658	135

The number of pupae collected increased gradually in May and early June, and reached a sharp peak in late June. Relatively few pupae were found after the first half of July. The sharp peak in numbers of pupae collected in June and the relatively small number of pupae collected before and after this period suggest that *C. melleus* has only one generation per year on Long Island.

The duration of the pupal stage of two *C. melleus* females, reared from larvae, was 5 and 14 days respectively. Adults emerged from 12 pupae collected in the field an average of 6.3 days after they were collected.

ADULTS. *C. melleus* adults are widely distributed on Long Island. They were collected at Asharoken, Hampton Bays, North Sea, Noyac, and Orient Point. The seasonal distribution of annoying adult coastal *Culicoides* on Long Island is discussed in a companion paper (Jamnback, Wall and Collins, 1958).

Culicoides canithorax HOFFMAN. *C. canithorax* is also widely distributed on Long Island. Adults have been collected from Jones Beach, Asharoken, Hampton Bays, North Sea, and Orient Point. Larvae and pupae were collected from salt marsh sod samples dried in Berlese funnels. As with *C. melleus,* larvae and pupae were reared in individual corked vials containing a few drops of bay water and bits of marine algae. The earliest pupation noted occurred in the laboratory. A larva collected on March 26, 1957 pupated on April 23. A male emerged 5 days later. Seven larvae were reared to adults, 6 larvae to pupae, and 4 pupae to adults. The pupal period of the seven adults reared from larvae ranged from 4 to 8 days, with an average of 5.7 days. In addition to these, 18 females and 10 males were recovered from Berlese funnel collecting jars. These presumably hatched from pupae in the sod samples. Larvae, pupae, or adults of this species were recovered from sod samples taken in salt marshes bordering or adjoining Long Island Sound, Peconic Bay, Moriches Bay, and Shinnecock Bay on Long Island. They were widespread in the salt marshes and were recovered from sod samples which had *Spartina alterniflora, Spartina patens, Distichlis spicata, Scirpus* spp., and *Salicornia* spp. as the dominant plant cover. They appeared to be particularly abundant in wet marsh that was covered by almost every high tide, where the *Spartina alterniflora* grew to a height of two feet or more, and the sod had a thin covering of mud.

It is interesting to note that the breeding habitats of these two salt-water species are mutually exclusive, i.e., *C. melleus* was never found breeding in the salt marsh proper and *C. canithorax* was never found breeding in intertidal sand.

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TESTS WITH A NEW GRANULAR PARIS GREEN FORMULATION AGAINST *AEDES, ANOPHELES,* AND *PSOROPHORA* LARVAE

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Since Barber and Hayne (1921) first published on paris green as a mosquito larvicide 36 years ago, almost all of the research on this material has been directed toward making the paris green more floatable so as to improve its efficiency in killing surface-feeding anopheline larvae. Griffitts in 1927 published on a moist sand-paris green formulation and showed conclusively that this formulation was very effective against larvae of *Aedes taeniorhynchus, Aedes sollicitans,* and *Culex quinquefasciatus* under field conditions (Griffitts, 1927).

Several papers were published during the nineteen thirties on the use of paris green against culicines (for more complete reviews of the literature on this subject see Herms and Gray, 1940; Barber, 1941; Covell, 1941; and Bishopp, 1949). But there apparently has been no real effort to develop improved formulations of paris green for use against culicine larvae since Griffitts' contribution 31 years ago.

The research reported here is indirectly related to experiments conducted by King and McNeel in Pinellas County, Florida in the thirties (King and McNeel, 1938). Using the simple method of applying a suspension of paris green in water from sprinkling cans, these workers reported excellent kills of *Aedes taeniorhynchus* and *Psorophora confinnis* at dosages as low as one pound per acre. Thus King and McNeel confirmed the earlier work of Griffitts with paris green against culicines, but this promising line of investigation apparently was not continued beyond the nineteen thirties.

In the summer of 1956, Mr. Claude Strickland of St. Petersburg, Florida, who was director of mosquito control in Pinellas County when King and McNeel did their work there, recommended that paris green be tried as a larvicide to control an unusually large brood of salt-marsh *Aedes* that occurred in Pinellas County that year. Since approximately 5000 acres of marsh were to be treated in the space of a few days, hand application of larvicides obviously could not be used, and granular parathion applied by aircraft was used as an emergency measure. Following this work in Pinellas County in 1956, Mr. John A. Mulrennan, Director, Bureau of Entomology, Florida State Board of Health, requested that paris green be tested by the Entomological Research Center against salt-marsh mosquito larvae.

Paris green in suspension in Triton X-100 and water was included as one treatment in small-plot larvicide tests against salt-marsh *Aedes* conducted in cooperation with the Indian River Mosquito Control district in the fall of 1956. Results of these preliminary tests with paris green (not published) were very encouraging, and in 1957 efforts were devoted toward developing a granular formulation.

METHODS. Since paris green is insoluble in most solvents, the problem of formulating was very different from the usual method of dissolving the insecticide in acetone or other solvents for absorption by granular bases. This problem was solved by using vermiculite as the granular base and sticking the paris green to the base with a water-miscible sticker.

Experimental formulations utilizing various stickers were evaluated in the laboratory to determine the effectiveness of the stickers in holding the paris green on the vermiculite and the effectiveness of the best of these formulations against larvae of *Aedes taeniorhynchus.* Biological tests were randomized and replicated and were conducted in metal containers of one square foot size. Dosage was in pounds per

acre and was varied either by volume or concentration. The more promising formulations were tested both in brackish water (salinity about 20/1000) and in fresh water.

All field tests were conducted with the formulation considered best by laboratory evaluation, and which for convenience of identification is designated ERC Larvicide No. 1.

FORMULATING PROCEDURE. The procedure for making this formulation is as follows. The granular base is prepared by removing dust-size particles from No. 4 grade vermiculite with a 30-mesh screen. The sticker is an oil emulsion containing by volume 60 percent of 40W motor oil, 30 percent water, and 10 percent Triton NP-56.* It is best to dissolve the Triton in hot tap water before emulsifying the oil.

In formulating 10 pounds or more of granular paris green, the vermiculite is placed in a tumbler (a cement mixer works well) and the emulsion is sprayed as a fine mist over the vermiculite as the mixer is in motion. A nozzle pressure of 40–50 p.s.i. is required to spray the emulsion. It is important that the emulsion be sprayed over the vermiculite; if poured or dripped, lumping will occur. After blending the sticker and vermiculite thoroughly, the paris green is added in small amounts until a uniform blend is obtained. The finished formulation is spread and air-dried for 24 hours to remove excess moisture. Mechanical drying has not been tried to date but probably could be used.

A formulation containing 15 percent by weight of paris green requires four gallons of emulsion per 100 pounds of formulation. The 15 percent material weighs approximately 15 pounds per cubic foot after excess moisture is removed.

When this formulation is applied to the water surface, the vermiculite will float for several hours but paris green begins immediately to be released and settles slowly to the bottom. However, some of the released paris green will remain on the water surface for several days in laboratory containers if not disturbed. Thus the formulation appears to meet the requirements both for surface-feeding and subsurface-feeding larvae.

TEST RESULTS: LABORATORY TESTS. Paste, mucilage, powdered and liquid starch, motor oil, and flour paste all made what appeared to be good formulations but all failed in biological tests, presumably because sufficient paris green was not released in water.

In fresh water, a 10 percent paris green formulation with methyl cellulose solution as the sticker killed 100 percent of third instar *Aedes taeniorhynchus* at dosages as low as 0.1 lb./acre of paris green. In brackish water (salinity 21.3/1000) this same formulation killed only 78 percent at a dosage of 0.5 lb./acre and gave correspondingly lower kills at lower dosages.

Of all stickers tested, oil in combination with a wetting agent, such as Triton or sodium lauryl sulphate, performed best in killing larvae both in fresh and saline waters; several of these formulations were completely effective at dosages ranging from 0.3 to 0.5 lb./acre of paris green.

FIELD TESTS: All field testing of the granular paris green formulation to date has been in small plots in Indian River County, the formulation being applied with a hand shaker. Due to the early termination of salt-marsh mosquito breeding in Florida in 1957, no opportunity was available for tests by airplane application during the 1957 season. Therefore the effectiveness of this larvicide when applied by aircraft is not known at this time.

In September, 1957 several old ditches in the salt marsh were partitioned with earth dikes to make plots of 300 to 500 square feet in area. Approximately 5000 third and fourth instar larvae of *Aedes taeniorhynchus* from another area of the salt marsh were placed in each plot. The plots were naturally stocked with a small population of *Anopheles bradleyi*. After allowing several hours for the *Aedes* larvae

* Rohm & Haas Co., Philadelphia, Pa.

to become "settled" in the plots, ERC Larvicide No. 1 containing 15 percent (W/W) paris green was applied with a hand shaker at dosages of 0.15, 0.30, and 0.60 lb./acre of paris green. All treatments were applied at a gross volume of four pounds per acre; this was accomplished by diluting the smaller dosages with untreated vermiculite.

Water in the plots was 8 to 20 inches deep and there was a moderate vegetational cover consisting primarily of salt grass, *Distichlis spicata* (L.) Greene, and woody glasswort *Salicornia perennis* Mill. Results are shown in Table 1.

TABLE 1.—Test results with granular paris green against larvae of *Aedes taeniorhynchus* (Wied.) and *Anopheles bradleyi* King, September, 1957 *

Paris Green Lbs./Acre	Average No. Larvae per Dip				Reduction —24 Hrs.	
	Pretreatment		24 Hrs.			
	Aedes	*Anopheles*	*Aedes*	*Anopheles*	*Aedes*	*Anopheles*
0.60	14.5	.95	0.1	.00	99.3	100
0.30	10.1	.95	0.9	.00	91.1	100
0.15	4.7	.38	0.7	.03	86.2	92.3
Check	3.3	.55	2.2	.45	33.3	18.2

* Replications: Treated plots 2; check 1.

The reduction of larvae in the check plot (Table 1) was more apparent than real. In the case of *Anopheles* the apparent reduction was due to the small initial population. At pretreatment inspection, the *Aedes* were concentrated near one end of the check plot and at post-treatment inspection they were noted to be widely dispersed, causing a reduction in the average number per dip. The many dead larvae found in all plots except the check further supported the effectiveness of the treatments.

The second field test against *Aedes taeniorhynchus* was conducted October 3, 1957 on a recently constructed hydraulic fill. This fill was on mangrove marsh in which the mangrove trees were not cleared before filling. After filling, the mangroves shed their leaves, which formed a ground cover very favorable for oviposition by *Aedes taeniorhynchus*. Subsequent rains hatched the eggs in numerous small pools on the fill, some of which were modified to form small plots for a larvicide test.

Sixteen plots, each 200 square feet in area and averaging 10 inches in depth, were arranged in four blocks, making the test a standard randomized-blocks design with four treatments and four replications. All treatments were applied at a gross volume of three pounds per acre at dosages of 0.15, 0.30, and 0.45 lb./acre of paris green.

Results of this test are shown in Table 2. These results confirmed the results against *Aedes taeniorhyncus* in the first

TABLE 2.—Tests results with granular paris green larvicide against *Aedes taeniorhynchus* (Wied.), October, 1957 *

Paris Green Lbs./Acre	Average No. Larvae per Dip			Percent Reduction	
	Pretreatment	4 Hrs.	24 Hrs.	4 Hrs.	24 Hrs.
0.45	83.7	0.7	1.0	99.1	98.8
0.30	58.1	11.6	6.5	80.0	88.9
0.15	82.7	59.3	28.0	39.2	66.1
Check	67.7	71.1	71.4	—	—

* Four replications.

test and show that a dosage of 0.45 to 0.60 pounds of actual paris green per acre was adequate to give good control of *Aedes taeniorhynchus* under the conditions of these tests.

Table 3 shows results of tests with ERC

DISCUSSION. The data obtained in the field tests again confirm the earlier reports of Griffitts (1927) and King and McNell (1938) that paris green larvicide can be used effectively against a number of culicine species. The failures reported with

TABLE 3.—Test results with granular paris green against *Psorophora confinnis* (L.-Arr.), 1957 *

Paris Green Lbs./Acre	Average No. Larvae per Dip			Percent Reduction	
	Pretreatment	4 Hrs.	24 Hrs.	4 Hrs.	24 Hrs.
0.60	11.7	—	0.8	—	92.9
0.45	7.0	1.0	0.5	85.7	92.6
Check	4.1	4.5	4.3	—	—

* Three replications.

Larvicide No. 1 against third and fourth instar larvae of *Psorophora confinnis*. The table is a summary of similar tests replicated in time between September 18, and October 23, 1957, all in the same area.

Plots were located in roadside ditches and varied in size between 1000 and 3000 square feet. Water depth ranged from 1 to 13 inches and all plots contained a moderate to very heavy cover of pangola grass, *Digitaria decumbens* Stent. A gross volume of 3 lbs./acre of formulation was used in all tests; a 20 percent formulation was used to obtain the 0.60 pound dosage.

Data in Table 3 indicate that there was no significant difference in the average kill at 0.45 and 0.60 lb./acre. With the 0.45 lb. dosage, the percent reductions in 24 hours for the individual plots were 86 percent, 100 percent, and 98 percent; for the 0.60 lb. dosage, the reductions were 99 percent, 85 percent, and 100 percent. In one plot receiving the 0.45 lb. dosage, the kill was 100 percent in four hours after treatment, and the average number of dead larvae per dip was about the same as for live larvae before treatment. The higher and more rapid kills of *Psorophora confinnis* seemed to be correlated with plot conditions of clear water, moderate to sparse vegetative cover, and a firm bottom. However, sufficient testing has not been conducted to make this observation positive.

its use against culicines (see Covell, 1941) could very well have been due to the formulation used. The literature on paris green as an anopheline larvicide leaves little doubt that most dust formulations give poor results against culicine larvae.

Considering the many problems attendant on the use of organic compounds as larvicides, especially the potential hazards to fish and other beneficial forms of life and the ever-increasing "resistance" problem, it would appear that thorough investigation of paris green, as well as other inorganics, offers one of the most promising approaches for the future in control of mosquitoes with chemicals. The literature leaves no doubt that paris green was used as an anopheline larvicide for more than 30 years with a good margin of safety to man, domestic animals, fish and other animals. Also, to the authors' knowledge, no "resistance" to this chemical by mosquitoes was reported in its long history as a larvicide.

In the tests reported in this paper, there was no opportunity to observe effects of the granular formulation on fish, but aquatic Coleoptera, Hemiptera, Odonata, amphibians and other observed forms of life appeared not to be affected at the dosages used.

Calibration tests are being conducted with a Stearman airplane for dispensing the granular formulation by air. The light

weight of the material presents some problems when using standard dusting equipment on aircraft. Research to improve the present formulation by increasing the bulk density and eliminating the drying process is being continued.

Due to the presently limited experience with this formulation, only general suggestions may be made regarding its use at this time. Since paris green kills only when consumed by the larvae, good coverage of the breeding area is required. Although 91 percent of first instar *Aedes taeniorhynchus* were killed in one laboratory test, it is felt that better results might be expected against the more active, later instar larvae. Pupae, of course, are not affected, and there appears to be little or no residual effect at dosages used to date.

Calibration tests with aircraft presently indicate that the gross volume to ensure good coverage and adequate swath when applied by airplane might be at least four to six pounds per acre. Three to four pounds per acre appear to be an adequate volume when applied by hand. A dosage of approximately 0.5 lb. per acre of paris green appears adequate for the species studied and may easily be obtained with any desired volume by adjusting the concentration of paris green in the formulation. At these rates, the cost per acre for materials should compare favorably with the least expensive larvicides now in use.

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TOP THIS ONE!

Recently I was out on the range with Clarence Blair, field man for the Kamloops Mosquito Control Committee, who in past years has plodded many a weary mile with a knapsack sprayer on his back, treating the rangeland pools. This year, however, he stopped his Land Rover beside a good-sized slough, drew out a schoolboy catapult, leaned out of the window, spotted "Tossits" accurately around the margin of the pool, and moved on to the next in a matter of a few moments. It seems to me that this is a wrinkle with a wide application, that should be reported where it will do most good.—L. COLIN CURTIS, Research Officer (Agriculture), Dominion Entomological Laboratory, Kamloops, B. C.

RESIDUAL EFFECTIVENESS OF SIX ORGANOPHOSPHORUS COMPOUNDS AGAINST *ANOPHELES QUADRIMACULATUS* SAY

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Residual applications of chlorinated hydrocarbon insecticides have been used to control anopheline mosquitoes in various parts of the world. Reports from Java, Greece, Lebanon, Nigeria, Saudi Arabia, and the United States have indicated that resistance to one or more of these compounds, particularly DDT, lindane, and dieldrin, has developed in five species of this genus (Busvine 1957). In most instances the degree of resistance is not so great as to eliminate practical control with these insecticides, but the need for other toxicants to supplement those now in use may soon be felt. Organophosphorus compounds have been utilized with success both as larvicides and adulticides against other Culicidae where resistance to chlorinated hydrocarbons was present (Gjullin *et al.* 1956, Stivers 1956, Gahan *et al.* 1957, and Davis *et al.* 1957).

In the spring of 1957 laboratory tests were initiated to compare the duration of effectiveness of residues of several organophosphorus compounds and DDT against adults of a nonresistant colony of *Anopheles quadrimaculatus* Say.

Malathion, Diazinon, Dow ET-57 (sampled as ET-14), Dipterex, Am. Cyanamid 4124, chlorthion, and DDT were tested against 3- to 4-day-old adults of undetermined sex in a series of duplicate tests. Acetone solutions of the insecticides were sprayed on plywood panels at the rate of 100 mg. of active ingredient per square foot. The panels were tested after aging for periods ranging from 1 to 180 days. Enough panels were sprayed with each insecticide to avoid the necessity of using any panel twice. In each test 20 to 40 mosquitoes were exposed on treated panels for periods ranging from 5 to 120 minutes, after which they were transferred to cylindrical screen cages, provided with a 10-percent sugar solution in pads of absorbent cotton, and held for 24 hours, when mortality counts were made. The results are given in table 1.

Malathion was equal or superior to DDT, giving 100 percent mortality in 30- or 60-minute exposures throughout the 180-day test period. Diazinon was more effective than malathion through 14 days of aging, about equal after 30 to 60 days, and slightly less effective thereafter. Dow ET-57 was also more effective than malathion through 14 days, but much less effective thereafter. Am. Cynamid 4124 was slightly less effective than malathion, but gave 100 percent mortality in 60- or 120-minute exposures throughout the 180-day period. Chlorthion and Dipterex were less effective.

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TABLE 1.—Percent mortality of *Anopheles quadrimaculatus* after exposure to residues of insecticides aged for various periods (Average of 2 tests)

Insecticide and Exposure (Minutes)	Age of Residue (Days)								
	1	7	14	30	60	90	120	150	180
First Series									
Malathion									
5	93	41	29	2	—	—	—	—	—
15	100	75	82	23	—	—	—	—	—
30	100	100	100	96	91	96	98	100	91
60	—	—	100	100	100	100	100	100	100
Diazinon									
5	100	100	100	11	—	—	—	—	—
15	100	100	100	18	—	—	—	—	—
30	100	100	100	97	100	72	11	—	—
60	—	—	—	100	100	85	55	88	58
120	—	—	—	—	100	100	100	100	100
Dow ET-57									
5	100	98	100	5	—	—	—	—	—
15	100	100	100	9	—	—	—	—	—
30	100	100	100	27	—	—	—	—	—
60	—	—	—	42	98	31	35	67	26
120	—	—	—	89	67	100	100	100	56
DDT									
5	55	46	25	29	—	—	—	—	—
15	91	59	51	54	—	—	—	—	—
30	100	100	85	100	94	97	100	83	79
60	100	100	100	100	100	100	100	100	100
120	—	—	—	—	—	100	100	100	100
Check									
—	9	6	10	0	9	10	0	6	0
Second Series									
Dipterex									
5	17	5	—	—	—	—	—	—	—
15	96	97	47	0	—	—	—	—	—
30	100	85	95	19	—	—	—	—	—
60	—	—	100	97	100	36	93	18	—
120	—	—	—	100	100	96	100	63	53
American Cyanamid 4124									
15	12	21	—	—	—	—	—	—	—
30	71	69	39	26	—	—	—	—	—
60	—	98	100	100	45	82	100	100	47
120	—	—	100	100	100	100	100	100	100
Chlorthion									
15	4	11	—	—	—	—	—	—	—
30	52	77	27	15	—	—	—	—	—
60	—	72	100	98	97	94	93	63	10
120	—	—	100	100	100	100	100	100	35
DDT									
5	6	29	—	—	—	—	—	—	—
15	61	65	93	98	—	—	—	—	—
30	79	98	94	100	—	—	—	—	—
60	100	100	100	100	100	100	100	100	95
120	—	100	100	100	100	100	100	100	100
Check									
—	4	10	6	5	2	4	0	0	5

MOSQUITOES AFTER THE FLOOD

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Three and one-half years ago, in early October 1954, the entire Chicago area received a total of 8 inches of rain in 48 hours and as much as 12 inches in the western suburbs where our district is located. Property damage was estimated at over twenty-five million dollars.

Fortunately, this rain came after the end of the local mosquito breeding season while our district employees were on vacation. Local mosquito control people congratulated themselves that this rain was well timed. We asked ourselves the question "What would we have done if we had had this rain in July or August?"

We had to answer this question last summer when mosquito control in the Chicago area received its supreme test following the record rainfall of 6.16 inches in twelve hours on the evening of July 12, 1957. This set a new rainfall record, the previous one dating back to 1889.

Two more rains of over an inch each came before the end of the month and another $3\frac{1}{2}$ inches during the second week in August, a total of $12\frac{1}{2}$ inches in a thirty-day period. The resulting flooding was estimated at fifteen times the maximum after normal heavy rainfalls. Fortunately, temperatures were abnormally low; only three days were above 90°.

Control measures were divided into three phases—1, Drainage and Inspection; 2, Floodwater Control by Larviciding and Fogging and; 3, *Culex* Control by Larviciding.

1. DRAINAGE AND INSPECTION. No spraying was done for the first four days after the rain, enabling large areas to drain partially, thereby reducing acreage to be sprayed. During this time all inspectors and technical staff were engaged in determining extent and depth of flooding and making spot checks to determine size, amount and kind of breeding. As it was evident that a new hatch of overwhelming proportions would reach maturity and cause annoyance about July 24, the field men opened as many clogged ditches and drains as possible to increase the speed of runoff of floodwater. Much of this clogging of drains, etc., was caused by silt and debris swept into streams by the downpour.

Anticipating the extensive annoyance that was due, information explaining the problem, and the fact that excessive annoyance would occur in spite of our efforts, was sent to all local and Chicago newspapers. The papers published this news of the problems of our district, and also of the other districts in the Chicago area. Bulletins were given on several TV news programs. As a result of this publicity, the reaction of the public was favorable and though we received a flood of complaints of annoyance, practically no criticism of our efforts was registered.

Aedes vexans larvae were found in nearly every pool of standing water, averaging 700 per dip, except along the river and creeks where the current was too swift. For example, one cornfield, five acres in extent, was completely flooded for the first time. The inspector found *Aedes vexans* larvae here at a rate of 1,000 per dip. Likewise, *Culex pipiens* breeding was found at an abnormally high rate in nearly all polluted areas. The breeding was so extensive that it was necessary to spray all standing water without inspection.

2. FLOODWATER CONTROL BY LARVICIDING AND FOGGING. On July 17, the fifth day after the rain, larviciding was begun, using four mist-blowers and a hand crew with hand cans to spray as much standing water as possible before emergence of the first flight. This work continued without interruption through Saturday and Sunday. By Monday evening nearly all large areas were sprayed. Emergence of the

first flight of adults was widespread by this time. However, another new hatch of *Aedes vexans* appeared on Monday morning making it necessary to begin all over again; working through Saturday and Sunday of the following week.

Fogging operations, terminated the night after the rain, were resumed on the night of July 24 as the first flight had arrived as predicted and was causing annoyance. A new hatch was reported at this time in the Barrington area to the northwest of the District, due to another six-inch rain in that vicinity. Prevailing southwesterly winds prevented annoyance from this source.

Aedes vexans annoyance was materially reduced by the first week in August and permitted cessation of fogging from August 14 to 23. Although *Aedes vexans* were no longer a problem, *Culex pipiens* were far above normal, causing many complaints of mosquitoes in houses at night, particularly in Riverside and Western Springs. As the result of the 3½ inches of rain the second week in August, flooded areas were still four times the maximum and without exception breeding *Culex pipiens*. A few *Aedes vexans* larvae were found in some isolated areas because of blocking of ditches with flood debris, causing local flooding.

3. *Culex* Control by Larviciding. The third phase of emergency control measures began on August 6 when *Culex pipiens* annoyance became severe. This condition lasted until the middle of September before flooded areas had receded to normal. Cool nights drove the insects inside, aggravating the annoyance and causing a new flood of complaints. Using one well screened home as a barometer, from 5 to 46 female *Culex pipiens* were killed every night but one between August 5 and September 23. The large bodies of standing water disappeared imperceptibly making it necessary to continue larviciding until the end of September when cooler weather finally slowed down the reproduction of *Culex*.

Aedes vexans should be reduced in numbers during the coming year due to the excessively high water line after the July 12 rain that resulted in flooding and hatching of all viable eggs lying on the ground. With no more eggs to be hatched, *Aedes vexans* annoyance dropped very sharply after the first of August. As a result the only viable eggs lying on the ground next summer will be those laid after the flood of 1957.

Consumption of DDT by our district reached a new high of 46,140 pounds due to the increase in both larviciding and fogging. For the first time since the inception of the fogging program it was necessary to make nine complete coverages of the district and a tenth fogging in two villages, Riverside and Western Springs. Riverside with its winding streets, heavy vegetation and extremely deep lots, has always been difficult to provide with adequate protection, while Western Springs lies on the westerly boundary and receives the full impact of mosquito flights brought by the prevailing southwesterly winds.

This was an emergency never encountered before but the realization that such a situation might arise had often been considered and tentative plans made accordingly.

Our success, such as it was, was due to the flexibility of our equipment and the willingness of our employees, both permanent and temporary, to work long hours and do whatever was required.

TRENDS IN MOSQUITO POPULATIONS IN SALT LAKE COUNTY

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During 1956 and 1957 the South Salt Lake County Mosquito Abatement District collected and identified larvae from every mosquito source found, and attempted to determine the relative abundance of each species. The results of this investigation were compared, so far as possible, with the data obtained by Chamberlin and Rees in random larval surveys conducted for the Salt Lake City Mosquito Abatement District in the same and adjoining areas in 1930, 1931 and 1932. The comparison showed that some changes in population had taken place in the mosquito fauna of the area. Information contained in the annual reports of the Salt Lake City District, from light trap collections and reports in the literature confirmed these changes.

Chemical control procedures of abatement districts in Salt Lake County generally have reduced adult populations below nuisance levels, but have produced only temporary reductions in larval populations. For this reason trends in mosquito populations reported here are based on larval populations, which indicate more accurately than adult populations, how well a species is maintaining its numbers under abatement pressures.

Permanent control procedures have materially reduced mosquito habitats in Salt Lake County and have reduced the populations of many species. Unfortunately, quantitative data are not sufficient to demonstrate this reduction for some species; i.e., *Aedes dorsalis* and *Aedes campestris*.

Anopheles freeborni was collected in early surveys in most of Salt Lake County, both as larvae and adults, but was most abundant in the southeast portion of the county where more favorable larval habitats were present. During 1956 only 11 small breeding areas were found in this part of the county and in 1957 only 3 of these remained. In addition, 7 small pools that had not been inspected in 1956 were found to contain *A. freeborni* larvae in 1957. The nature and distribution of the present larval habitats of this species is such that virtual eradication in Salt Lake County appears possible. Since suitable habitats for this species are not close to existing populations, re-establishment of this species from other counties in the state is not probable if effective inspection and control are continued. The reduction of *Anopheles freeborni* is due primarily to a reduction of habitat through drainage, filling, construction of suburban housing and water pollution, and secondarily to chemical control measures. Since drainage of the remaining larval habitats is not presently possible, chemical control will be the means by which final eradication is attempted.

Aedes vexans has decreased materially in Salt Lake County. This species was collected commonly as larvae in early surveys and was a serious pest for many years. In August 1938 a severe migration of *A. vexans* moved into Salt Lake City from areas south of the city and caused considerable annoyance. The migration of this mosquito into Salt Lake City in 1938 was from areas in which detailed surveys were made in 1956 and 1957. These surveys showed *A. vexans* to be restricted now to a few small pools. If the larvae in these pools had been allowed to emerge as adults, they would have caused only minor, localized annoyances. In Salt Lake County larvae of this species are found primarily in ponds formed from the over-

flow of streams. Permanent control measures such as dredging the streams and filling the low areas along the banks have considerably reduced the larval habitat of *A. vexans* and it is no longer an important control problem in Salt Lake County. The removal of streamside vegetation also has apparently contributed to the reduction of the species.

Culiseta incidens was collected commonly in Salt Lake County when the first surveys were made in the early thirties. At the present time this species is still found in the canyons of the mountains that border the Salt Lake valley on the east but no specimens were taken in the valley in Salt Lake County in 1956 and 1957. The reasons for the reduction in numbers of this species in the valley are not definitely known, but control measures, particularly source reduction, undoubtedly have been a major factor.

Aedes flavescens was never common in Salt Lake County but specimens have been taken and are in the collection at the University of Utah. This species has not been collected in the Salt Lake Valley since 1931. In all probability the small population of this species was unable to withstand the pressures of mosquito control measures.

Culex pipiens has increased in numbers in Salt Lake County. It was not reported at all when the first surveys were made. Rees (1942) reported this species as rather rare in Utah and stated that only a few specimens had been taken in light traps in Salt Lake County. At the present time *Culex pipiens* is a common species in the county and is taken frequently in light trap and larval collections. Over 200 bodies of water were found containing larvae of this mosquito in South Salt Lake County in both 1956 and 1957. Increasing amounts of polluted water, which this species prefers as a larval habitat, and an increasing number of suitable habitats which have arisen in new residential districts have probably contributed to the increase of this species but other factors, as yet unknown, have possibly influenced this increase.

Aedes nigromaculis may be increasing in Salt Lake County. Rees (1954) reported that *A. nigromaculis* was present when the first larval surveys were made in the vicinity of Salt Lake City but that the species gradually had disappeared and could not be found after several years of control operations. He reported a large brood appearing in a limited area in 1953 and asks: "Is this a remnant of a species disappearing from the area under mosquito abatement pressures or is it a recent revival of the species which may develop into a major control problem?" In 1956 twelve spots were found with larvae of *A. nigromaculis* and 18 spots were found in 1957. The distribution of these areas apparently does not coincide with available habitat. Of the 30 localities from which *A. nigromaculis* larvae were reported in 1956 and 1957, 29 of them were either in an area that had been subjected to control for many years or were less than ¼ mile away from controlled areas. The remaining larval producing area was found in 1956 about 6 miles south of the others. So far as can be determined, suitable larval habitats for this species extend 15 miles beyond the actual known distribution of the larvae in the Salt Lake Valley. The possibility that control operations have influenced the distribution of this species in the county must at least be considered in future investigations. The question asked by Rees in 1954 can not yet be answered with certainty but the available evidence indicates that an increase may be occurring. This is particularly interesting in view of the increase of *A. nigromaculis* that has occurred in California (Husbands 1955).

Summary and Conclusions. The composition of mosquito larval populations in terms of both relative and absolute numbers of each species has shown several changes since records were first kept by mosquito abatement districts in Salt Lake County. Permanent control measures probably have significantly reduced local populations of *Aedes campestris* and *Aedes dorsalis* but quantitative data are not adequate to fully substantiate this. *Anopheles*

freeborni has been reduced in numbers by the elimination of its larval habitats to a point where complete eradication may be possible. Source reduction procedures of mosquito abatement districts also have reduced populations of *Aedes vexans* until they are no longer an important control problem in the Salt Lake Valley. *Aedes flavescens* apparently has disappeared from Salt Lake County and *Culiseta incidens* has become extremely rare in the valley portion of the county. The reasons for the disappearance or reduction in numbers of these two species is not known but control operations probably have been responsible.

Culex pipiens has increased greatly in numbers probably due to increased water pollution and the development of suburban housing areas.

Aedes nigromaculis appears to be increasing in numbers and the distribution of the larvae show that the increases have occurred in areas where control practices have been in operation for many years. Reasons for this increase have not yet been determined.

Chemical control procedures generally have reduced adult populations of mosquitoes in Salt Lake County to below nuisance level but appear to have had little inhibitory effect on the ability of a species to produce succeeding generations. Source reduction procedures have been the only effective means of permanently reducing the numbers of the well established species in Salt Lake County.

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TRENDS IN MOSQUITO CONTROL, WINNIPEG, MANITOBA, CANADA

E. J. STANSFIELD
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Two events of consequence have occurred in the Greater Winnipeg Mosquito Abatement District, of 250 square miles, and with a population of 420,000.

1. A working association with the University of Manitoba, Department of Entomology, was arranged, in 1957. 2. Pre-season mosquito control has become an important part of our operations over the last ten years.

A Grant was made by the Mosquito District in 1957 to the University of Manitoba under which a graduate student was employed under the supervision of Professor A. J. Thorsteinson, Head of the Department of Entomology.

This project has two main aims: 1. To investigate the problems of mosquito control in Greater Winnipeg, in the interests of economy and efficiency, and suggest control measures. 2. To evaluate the results of such control work in a systematic manner.

The first of such evaluations by the Department of Entomology was their report of the successful results obtained by pre-season application of one pound DDT per acre on 7,928 acres of bush and swamp land.

The following is a part of the report presented by Mr. D. Smith, B.S.A.

"During the summer of 1957 a continuous survey of the Greater Winnipeg area was carried out by the Department of Entomology, with the object of evaluating the effectiveness of pre-season treatment for the past two years.

"The above-normal rainfall in June made this an excellent year for such an evaluation.

"In the winter of 1955–1956, 564 acres of bush were treated by plane with one pound DDT per acre, using 10 percent DDT tobacco stem granules. No breeding occurred in the treated area during the summer of 1956.

"To determine the long lasting effectiveness of this type of treatment over a period of two years, 177 acres was left untreated in the 1956–1957 winter. No breeding was noted until July 8th, when light breeding was observed.

"In the winter of 1956–1957, 6,117 acres were treated by plane on bush areas using one pound DDT per acre in 10 percent DDT tobacco stem granules. No breeding was observed despite above-normal rains in June. In contrast to this, untreated areas were breeding freely, and had to be treated several times during 1957.

"Adult populations were determined by means of four mosquito light traps. Peak activity occurred on July 12, probably related to heavy rain in June, followed by excessive heat in July.

"The maximum number of female mosquitoes caught in one trap on one night was 436: the average per trap from June 14 to September 16 was 40. The largest flights of mosquitoes occurred during July and August. Adult activity was negligible during May, June and September."

Pre-season control starts in October with ground equipment, followed in November with the plane. The Piper Cub plane has a 72-gallon tank for liquids, and a hopper that can take 300 pounds of granules. It operates on wheels, or on skis for snow. By entering into a 2-year contract with Teal Air Ltd., rent for the plane is reasonable at 20 cents per acre for spray work, and 40 cents per acre to apply granules.

In winter, truck loads of granules supply the plane close to the scene of operations. The snowfall of 99.5 inches in the winter of 1955–1956 was no problem in taking off and landing.

Tobacco stem granules are now in short supply as a carrier for DDT, so other forms of carrier granules are being tried. Of these, 20 percent DDT vermiculite, No.

4 grade, appears to be preferable from the point of view of economy, cost per acre and absorptive capacity of the carrier.

Considerable saving could be effected if one treatment every two years would prevent breeding. To test this idea, 1000 acres of marsh are being treated with 1½ pounds DDT per acre this winter.

The growth of pre-season control may be judged by comparing the figures on acreage treated in the winters 1955–56 and 1956–57 (table 1).

RESULT OF PRE-SEASON CONTROL. In 1957, for the first time on record, fogging was not necessary in May or June to kill adult mosquitoes. This was probably due to the preseason application of DDT by granule and spray, which prevented breeding on 7928 acres of wet land. Men and machinery were thus released to control other areas which were breeding in the usual way from April 17.

TABLE 1.—Acreage treated in pre-season control work

Method	Winter of 1955–56	Winter of 1956–57
From the air	564 acres	6117 acres
From the ground	1357 acres	1811 acres
Total	1921 acres	7928 acres

MOSQUITO CONTROL HIGHLIGHTS FROM THE STATES

MARYLAND

Maryland has just completed its second season of operation under the 1956 appropriation which established a state-wide program of support for mosquito control activities.

A highlight of the year was the completion of our Eastern Shore Headquarters Building. This building of cinder block construction, built at a cost of $40,000.00 provides office space for our Eastern Shore Headquarters personnel, a shop for the maintenance of equipment, storage space for insecticides and a number of garages for spray equipment. It is located on State property and serves as a center for supervising mosquito control activities for the Eastern Shore region. We believe maintenance costs on equipment will be reduced considerably by having our own maintenance shop.

We continue to divide our control program into a temporary control and a permanent control program for administrative purposes. The temporary control continues to be largely an attack on the adult mosquito to give our people a chance to enjoy their porches and gardens in the early evening hours. This year 197 communities participated in our spray program, as compared with 82 last year. This increased load required the adding of three additional spray machines to our State-owned equipment. This equipment was operated in two ways; by rental to the community for local operation, or by crews furnished by the State. Securing good temporary help continues to be a problem.

June and July were rather dry and control was satisfactory in most places. About the middle of August the rains began and extensive breeding resulted. In our tidewater areas *Aedes sollicitans* poured out of the marshes in such numbers that with equipment operating night and day we were able to give only limited relief. This situation continued until cooler weather resulted in an abatement of breeding.

We do not have a large enough program to do much larviciding. In two areas of the State we carried on a little larvicide work using insecticides in the granular form. We reduced the larval population

but the areas treated were too small to result in control.

Financing a mosquito control program is always a problem. I will not leave the subject of temporary control without bringing to your attention the way in which one community met this problem. Even with the State paying fifty percent of the cost many of the smaller communities find it difficult to raise their share of a very limited budget. St. George's Island is such a community. It is a low, marshy island about three quarters of a mile wide at its widest and about two and a half miles long. It has a population of about 200 people who make their living mainly by fishing, crabbing, and dredging oysters.

When the people of St. George's Island learned that aid was available they organized a group known as the St. George's Island Improvement Association. A few of the more affluent citizens loaned the group enough money to buy a fog machine and the members rotated the detail of fogging the island among themselves. They paid the debt on their equipment by giving crab feasts and oyster dinners. St. George's Island is a splendid example of what a community can do with little money but a lot of determination to do something about mosquito control.

One of the highlights of the year was the increase in permanent work projects. To take care of this increase in permanent work we added another tractor to our equipment specially equipped with scavel and backhoe for marsh work. Late in the year we acquired a special ditcher. Mr. Elwood Lynch, our engineer, will report on this in more detail. The permanent work consisted mainly of ditching marshlands near populated areas to establish circulation of water so that top minnows can enter and devour the mosquito larvae. In one county, main ditches were established by blasting because of poor footing for machinery. In the City of Oxford a number of tide gates were constructed to prevent tidal water from entering the city storm sewers. Most spectacular of the projects was the Coty Cox Branch clean up in the City of Salisbury. Here a meandering creek that supplied ample breeding near the heart of the city was brushed, ditched, filled and graded to eliminate the breeding of *Culex* mosquitoes.

This season we continued to depend on BHC as our principal insecticide. In some communities the odor of BHC was very objectionable to the residents. In these communities DDT was substituted. Later in the summer when the heavy populations of mosquitoes emerged following the rains, the insecticide malathion was substituted in a few communities. We have no evidence of resistance to any of our insecticides to date, and all complaints have been traced to improper application. —James R. Foster, Asst. Entomologist, Maryland State Board of Agriculture.

VIRGINIA

Waterfront property in Virginia is at a premium. Our population is growing and will continue to do so, but, our land area will remain substantially the same. This means that in the future we will have more people interested in property and because of the limited amount of waterfront property, it will become more and more valuable. Also, more and more families want and own small boats.

Along the coast there are many acres of salt marsh. These marshes are located between the highland and open water and, therefore, cut off access to the water from the adjoining property. They are unsightly and undesirable from many angles, principally because they produce enormous broods of salt marsh mosquitoes.

Now—before a voice is raised concerning wildlife, we are not speaking of the isolated marshland. This perhaps should be left for wildlife use. We are talking about the marshland in the cities and in areas of dense population. For example, there remain 1,000 acres of marsh within the boundaries of Norfolk City.

Potentially, this marshland is the most valuable land because of its proximity to

water. In its present state, it is a menace and a hazard performing no good, and producing no tax revenue. Bring the two thoughts together, and what do we get? Excavate a portion of the marsh so as to provide open water. Use the material thus excavated to build high land. You will end up with waterfront property and additional usable property and this alone is financial justification for doing it. By so doing, and as a by-product, the marsh with all its undesirable characteristics is permanently eliminated and additional tax assessments can be levied by the local government.

An example might explain better what we are trying to say: A real estate developer purchases good, high land at, let's say, $1,000 an acre. He divides it into lots, puts in streets, sewers, et cetera; and sells the lots at let's say $3,000. This may mean that he makes a gross profit of approximately $6,000 per acre. . . . Suppose that he purchases marshland at $50.00 per acre. He excavates one-half the marsh to make open water and uses the spoil to fill the remaining marsh. This means that the finished land will stand him $100 per acre plus cost of dredging. Let us say that this costs $900 per acre. You can see that he has no more invested but he can get two or three times the price for lots, so his potential gross profit jumps to $15,000 —plus or minus—per acre. Of course, these figures are hypothetical, but they do seem to demonstrate the tremendous potential of the marshland.

There is a developer in Virginia who is doing this very thing. He has purchased a hydraulic dredge and is expending approximately $1,000 an acre restoring marshland. He plans to subdivide it into one-half acre sites at a sale price of $10,000 per site. There is little doubt but that venture will be financially successful. Approximately 40 acres of marsh will be eliminated with a saving to the Mosquito Control Commission and thousands of dollars of assessed valuation will be added.

In a smaller way and in a different manner but nevertheless just as impressive, the same general idea was promoted during the past year at Virginia Beach. There was a cove, consisting entirely of marsh, located in the center of the city. Bordering on the marsh were fine homes built on what really should have been waterfront property, if they just had access to the water. The mosquito commission maintained ditches in the marsh and had to larvicide each week during the summer. In addition fogging from time to time was necessary.

The Virginia Beach-Princess Anne Mosquito Control Commission acted as a third party in bringing together the property owners and a contractor who would do the work. Twelve property owners were involved. A dragline crane was used to excavate from the middle of the cove and pile the spoil along the edge of the upland thereby making deep water, a sharp shore line and additional high land. The cost averaged approximately $1.00 per running foot. So a man with 200 feet frontage paid approximately $200.00. Some 15 acres of prolific mosquito breeding area have been permanently eliminated without the expenditure of public funds. The land owners who paid the bill are well pleased; in fact, they are singing the praises of the Mosquito Commission for its help because their property is greatly increased in value, beauty and usefulness.

Many thousands of dollars of public funds have been spent on salt marshes for ditching, spraying and fogging to reduce mosquito breeding; and, no doubt, these funds have been wisely spent. These expenses must continue as long as the marshes remain in their present state, for such control measures are only temporary. Of course, dredging and filling the marshes is not practical, or desirable in all conditions. However, when the plan can work it is ideal and mosquito control agencies can rightfully promote such activities. When you get someone else to do the job, because it is profitable to them to do so and, by so doing, you eliminate your problem—BROTHER! that is a good deal. —R. E. DORER.

PENNSYLVANIA

Mosquito control in Pennsylvania dates back to the days of the first World War, when large industries along the Delaware River in Philadelphia and Delaware County were handicapped by swarms of mosquitoes that seriously retarded war production. The U. S. Shipping Board, which had sponsored the great Hog Island shipyard just south of Philadelphia, one of the largest in the world, with ways to construct 28 oceangoing ships at one time, cooperated with the State Health Department and the other industries, and together a short but effective control program was carried out.

It was not until 1935, however, that a state law was enacted to permit setting up of County mosquito control commissions. Blair County in the west, including the valley where Altoona and other cities are located, and Delaware County promptly took advantage of the law and organized commissions and have carried on continuously since. For the last 10 years local communities in Bucks County just north of Philadelphia have been cooperating in control efforts with good results, culminating last year in the organization of a county-wide program actively supported by the County Commissioners of Bucks County.

In addition many other communities, including the City of Philadelphia, have operated some form of organized control work, so that at the present time at least 3½ million people in communities in more than 20 counties in the State are receiving some measure of protection. At least $300,000 are being spent annually in this work, which is being generally sponsored by and under the technical advice of the State Health Department.

As serious mosquito trouble in Pennsylvania is rather spotty and localized, there has not been the need for a wide scale control set up for whole regions as has occurred in some other states; there simply has not been the demand for mosquito control work to that extent.

As there are no salt marshes within the State and only very occasional flights of salt-marsh mosquitoes into southeast Pennsylvania from Delaware to the south or New Jersey to the east, the problem has been that of fresh water mosquitoes. These are chiefly *Culex* house mosquitoes, fresh water *Aedes* swamp mosquitoes and some *Mansonia perturbans.* In the northwest and southeast parts of the State some *Anopheles* are found. Altogether about 35 species have been collected in the State.

The results in 1957, were generally very good, with few adult mosquitoes reported. Rather dry weather reduced mosquito breeding in many places normally wet, but many running streams partly dried up and bred, and catch basins were more of a problem than usual, so good inspection and quick follow up in spraying were necessary.

Highlights of the year in Pennsylvania were first the starting of another good county wide program in Bucks County, the continuation of airplane spraying and also extensive hydraulic fills on the marshes of Philadelphia and Delaware Counties, the tying in of the rapidly developing sanitary landfill program in many sections of the state with mosquito control through the filling in of local low and marshy areas, better use of insecticides and the strengthening of public relations and personnel and equipment in all three counties and many local areas to get better results for the money spent.—Russell W. Gies, Executive Director, Mosquito Extermination Commission of Delaware County, Media, Pa.

NEW YORK

In terms of mosquito control, New York State may conveniently be divided into three regions: (1) Long Island, (2) New York City, (3) upstate New York. On Long Island, mosquito control has been a well-organized county activity in Suffolk and Nassau counties for many years, with

budgets of between half a million and a million dollars annually.

(1) Details of the work in Suffolk County have been described by C. T. Williamson, Director, in annual reports, and in a report given at the AMCA meetings in Miami Beach in April, 1957. (See *Mosquito News,* vol. 17, no. 3, for September, 1957.) In 1957, two occurrences worthy of note were two heavy flights of *Aedes sollicitans,* in the marshes bordering Moriches Bay and the east end of Bellport Bay. This emergence was caused by the clogging of Moriches Inlet and the consequent flooding of the marshes. Both of these flights were brought under control by aerial applications of DDT larvicide and adulticide.

During the latter part of May approximately 1500 acres of salt marsh were treated with 2½ percent dieldrin impregnated granules at the rate of 10 pounds per acre. This material was applied by helicopter and gave residual control from the date of application to the middle of September. One area of 300 acres was treated with the same material by a fixed wing plane. This method of application was found to be not as satisfactory as the helicopter application because of the narrow swath width and the inability of the pilot to overlap each swath sufficiently. Breeding was found in strips that had not been treated. It is planned this coming spring to treat by helicopter approximately 3000 acres of salt marsh with the dieldrin impregnated granules, re-doing the 1500 acres that were treated last year to determine whether this material will again give a long residual period.

The cooperative research program on biting flies, carried on jointly by the Suffolk County Mosquito Control Commission and the New York State Science Service was continued. In 1957, additional experimental treatments for the salt-marsh tabanids were made, and increased emphasis was placed on the sand flies (Heleidae). These studies are described in separate papers, by Jamnback, Wall and Collins.

Granular dieldrin discharged over the salt marsh at a rate of .3 lb. per acre from a helicopter by means of a whirling disc arrangement, under certain conditions gave control of the greenhead *Tabanus nigrovittatus,* as judged by both larval and adult counts. Of the three species of Heleidae studied, only *Culicoides melleus,* which was found to breed in a narrow intertidal band on protected sandy beaches, was the subject of control studies. The larvae were killed by topical applications of DDT emulsion.

From Nassau County, LeRoy Kinsey reported that "mosquito control was very successful in 1957, the 41st year of operation." Routine activities included the complete reconditioning of about 200 miles of the salt-marsh drainage system, or about a quarter of the total of 800 miles of ditches which drain 10,000 acres of marsh. The work was done mostly by hand labor.

An interesting development was the use of "Tossits" in catchbasins along the heavily traveled parkways, where it was unsafe to use vehicles which would have to stop or slow down in the traffic lanes. The inspectors, carrying Tossits, traveled on foot on the grass side strips beyond the curbs, thus permitting mosquito control vehicles to be kept off the parkways.

There were fewer mosquitoes captured in traps and less insecticide used than in the previous year. The trap catches of salt-marsh species were the second lowest in the history of the operations, and the number of service requests (complaints) relating to mosquito annoyance was the lowest on record—only 234 from a population of over a million and a half persons.

(2) Within the limits of New York City, which comprises five counties, there are thousands of acres of potential salt-marsh mosquito breeding areas as well as the usual urban breeding sites of freshwater species. In 1956 an unusual abundance of mosquitoes prompted the City Health Department to request the service of a consultant from the Public Health Service. His report was issued in January of 1957. It included recommendations for

the organization of a permanent comprehensive mosquito control program as soon as possible, with a director, entomologist, and borough supervisors and inspectors, and with emphasis on source reduction.

To date, there has not been sufficient time to put this program, or such portions of it as were adopted, into operation, and mosquito control in 1957 in New York City was limited to chemical control by helicopters, and fogging from ground operated equipment. The planning, administration and supervision of the program was under the direction of the Bureau of Sanitary Engineering of the Department of Health of the City of New York. The following details were supplied by the Assistant Commissioner, Environmental Sanitation.

"Approximately 7,500 acres of marshes were sprayed 7 times this year by helicopters at sunrise and sunset. Spraying cycles were initiated on June 8 and 28, July 20, August 2, 14 and 30, and September 14. The last 5 sprayings were scheduled to start 5 days after the peak high tides. There are usually two peak high tides a month in this area. These sprayings constitute larviciding operations.

"In the Boroughs of Richmond, Brooklyn and Queens, the Borough Presidents operated fogging machines. The chemicals employed were pyrethrins, butoxide and DDT in #2 fuel. Most of these sprayings could be considered an adulticiding operation. As a result of the program, it was difficult to find salt-marsh mosquito larvae or adult mosquitoes in this area this year. The control of other mosquitoes, though activities were limited due to inadequate funds, was generally satisfactory.

"Mosquito light traps were installed in, near, and distant from marshes. A control standard of 10 female mosquitoes caught in a mosquito light trap in 24 hours was considered a Nuisance Factor of 1. In a few instances, 90 female *Culex pipiens,* a Nuisance Factor of 9, were caught in 24 hours in a single light trap. Most of the time, the 20 light traps were found free of female salt-marsh mosquitoes. The largest number caught in any trap was 3 or 0.3 Nuisance Factor."

(3) Mosquitoes in upstate New York continued to arouse only local interest in comparatively small areas, and since no disease problems were involved, there was no pressure toward organizing for regional control. Thus far, the state health law, which permits a town board of health to engage in mosquito control and related activities, seems to have been adequate to meet whatever nuisance insect problems have aroused public interest, including, especially, mosquitoes and blackflies. There were about 1000 square miles included in regional blackfly control programs. The blackfly control programs involved larviciding in April and May. The most successful programs include two airplane sprays, one to control *Prosimulium hirtipes* and one to control *Simulium venustum*. These are the most troublesome species in New York State. A pint of 20 percent DDT per acre is sufficient to effect control.

In practice the two airplane sprays are usually supplemented by hand treatments in limited areas, and sometimes, also, a third spray is applied, where *venustum* develops over an extended period owing to differences in the rate of warming up of the streams.

The city of Ithaca (population about 30,000) has continued to contract with a local firm of "tree experts" to control mosquitoes. This is accomplished, apparently satisfactorily, largely by using a mist blower for both larviciding and residual adult spraying. All accessible potential breeding areas are covered several times during the season, either with or without the benefit of surveys. "Tossits" are also used.

In Geneva (population 18,000), about 50 miles from Ithaca, a similar program has not been so successful, possibly due to the fact that a large swampy area, a presumed mosquito source, is just outside the city limits and is not included in the program.

The City of Oneida (population 11,367)

contracted with an airspray operator to larvicide 650 acres of swampland and drainage ditches with 6 percent DDT at the rate of 1 gallon per acre. This was preceded by a dipping survey undertaken by the pilot himself, to determine species present. The larvae obtained were identified in the State Entomologist's office. They included: *Aedes stimulans, A. sticticus, A. fitchii, A. intrudens, A. communis, A. riparius and A. impiger.* Later, *Aedes excrucians* adults were collected.

No scientific evaluation of the control was made. All that can be said was that after the spraying no larvae could be found at most of the sites from which the pre-spray collections had been made, and that the community appeared to be satisfied with the results.

Residual applications of DDT by mist blower were made around state campsites as a routine procedure, and many summer hotels and private summer camps had fogging and mist-blowing contracts with local pest control operators.

It is probable that the gypsy moth control programs, which consisted of airplane spraying with DDT in early spring at the rate of ½ to 1 pound per acre, were responsible for a considerable abatement of the biting fly nuisance, especially in the counties of Delaware, Sullivan and Dutchess, and to a lesser extent in other eastern counties.—D. L. COLLINS, State Entomologist.

NEW ENGLAND

If mosquito control efforts in New England in 1957 were to be characterized in one word, that word would be "expanding."

In Massachusetts two new county projects, Plymouth and Dukes, were formed and two others, Bristol and Essex, came under consideration.

In Rhode Island a 60 percent increase in state matching funds is to be noted. Also in that state three new private groups in towns not organized joined the state program. Here might well be the beginnings of the realization in these towns of the benefits to be gained from organized mosquito control.

Another area of expansion is that of the development and use of mechanical devices for salt-marsh ditching. For many years the State of Connecticut has worked on this problem. The "scavel" plow is a concrete example of achievement. Several years ago a power backhoe was built at the mosquito control headquarters in Madison. Recently a clamshell bucket has been adapted to the same boom and dipper stick. Change-over from one to the other takes approximately two hours. More recently, another such machine has been designed, based on an Oliver OC–4–68 tractor. This machine will be fully hydraulic with a boom turning radius of 200°. Turning will be accomplished by a chain and sprocket arrangement with operator and cab turning with the boom, thus allowing the operator to face his work at all times. Mounting will be so that no outriggers will be necessary. Cost estimates for this machine total $6,500 exclusive of labor which will be done in the off season by the mosquito control personnel.

In Massachusetts the South Shore Project has been using a "scavel" for three years. This past year a hydraulic trencher mounted on a crawler tractor was added. The success of the South Shore "scavel" interested the Cape Cod Project, which resulted in their adding a unit to their equipment. These operations are being watched by other projects with the idea of adapting such machines to their area.

Although the interrelationship of the activities of mosquito control operations and those of wildlife conservation groups has been recognized in New England for as long as the writer has been active there, no concerted effort of the two groups to get together on an area-wide basis was made until this past year. The Northeastern Mosquito Control Association last winter had a speaker from the U. S. Fish and Wildlife Service at its 3rd Annual Meeting. Last summer a group

made up of both interests toured southern New England and at its 4th Annual Meeting in January the Northeastern Association heard from state wildlife representatives. One example of cooperation worthy of note, since it occurred in 1957, is a 125-acre plot at Galilee in Narragansett, R. I. This area is being worked by the state mosquito control and wildlife groups. The aim is to eliminate a prolific salt marsh mosquito source and improve an area recently made a sanctuary. Such contact is bound to minimize the effects of each operation on the other and if properly presented to the public, the former appearance of two groups pulling against each other will be corrected.

Encephalitis was in the minds of all workers the past summer; however the drought did not break and disease did not appear as in the previous year. The investigations of the U.S.P.H.S. Encephalitis Field Station at Taunton, Mass. will form a firmer basis for control operations in any future outbreak.

In the field of training and information, the Northeastern Mosquito Control Association continued into its fourth year. It will, in March, cosponsor a training course for local mosquito workers. Also, in this field, an informal organization of the Massachusetts project superintendents has been formed. Its monthly meetings will deal with common problems and serve as a clearing house for mutual aid activities.

Mosquito control efforts in Maine, New Hampshire and Vermont presently are limited to adulticiding. Some interest has been shown in Maine concerning salt marsh ditching methods. State departments provide advice to such control efforts regarding materials, equipment and methods.

I'm sure that all in New England will agree that progress has been made. Our Association and its members stand ready to help others in our area with their problems along mosquito control lines.—Lewis F. Wells, Jr., South Shore Mosquito Control Project, Quincy, Massachusetts.

ILLINOIS

The 1957 season was one of exceptionally abundant floodwater mosquito production in Illinois, following three periods of extremely heavy rainfall over the entire state. In the Chicago area, where eleven of the State's seventeen abatement districts are located, 3.51 inches of rain fell in a 5-day period in April, 4.58 inches in two short periods in June, and 6.24 inches on July 12–13 broke the all-time record and produced a serious flood. *Aedes vexans* is the major problem of fifteen districts in the State, and all reported record numbers of this species following emergence of at least three major broods. Of added significance is the fact that prehatch treatments applied to normal areas of inundation were rendered practically ineffective by this series of floods.

It will probably come as a surprise to some to learn that the so-called salt-marsh mosquito, *Aedes sollicitans* (Walk.), has for many years been the major mosquito problem in certain coal-producing areas of south-central Illinois. In fact, two districts in the state were organized to combat this pest, the Dupo district being formed as early as 1940, and the Franklin district in 1952. Horsfall[1] in 1956 reported that all of the known oviposition sites for *A. sollicitans* found in Illinois in the vicinity of coal mines and oil wells have sulfur in some form in the soil, and also that sodium, or other chlorides, are either absent or of a low order in the winter. Laboratory tests of soil and water from two *A. sollicitans* larval production sites in the South Cook District have also indicated the presence of relatively high sulfate contents.

The significance of getting more complete mosquito distribution data by employing thorough surveys is exemplified in two of the districts in the Chicago area where it has been found that several species have extended their previously

[1] Horsfall, William R. 1956. *Aedes sollicitans* in Illinois. J. Ec. Ent. 49(3):416.

recognized ranges. Since the publication of Ross's [2] handbook, six species have had their known northern ranges extended to northern Illinois. These species are *Psorophora varipes* (Coq.), *P. discolor* (Coq.), *P. cyanescens* (Coq.), *Aedes dupreei* (Coq.), *A. spencerii* (Theo.), and *Anopheles crucians* Wied. A southern record has been established for *Culiseta morsitans* (Theo.). A western species, *Aedes dorsalis* (Meig.), formerly known only from a few industrially contaminated sites in the state, is now known to occur in annoying numbers in parts of the Chicago area.

Within the past two years two bills have come up in the state legislature that would have had an adverse effect upon organized mosquito control in Illinois. The first bill, which would have had the effect of reducing the size of a district by chipping away at the boundaries, passed in modified form after suitable safeguards had been incorporated in it. The second bill, which would have made the office of trustee of the larger districts elective, rather than appointive as at present, died in House committee, but only after a favorable vote in the Senate, and after last-minute efforts on the part of some districts and our state association.

Following the severe outbreak of *A. sollicitans* in 1956, a bill was introduced in the state legislature in 1957 to provide for control of the *sollicitans* problem in the coal mining area of southern Illinois, specifically Saline and Williamson Counties. This bill, which originally provided for an appropriation of $25,000.00, was reduced to $10,000.00, and ultimately failed to pass.

The Illinois Mosquito Control Association is divided for purposes of local function into a Northern Section, made up of twelve districts, and a Southern Section composed of five districts. In June, 1957, the Southern Section held a successful meeting in Carbondale at which the public health aspects of mosquito control were discussed. Particular emphasis was placed upon the relationships existing between mosquitoes and arthropod-borne encephalitis, since there have been three outbreaks of this disease in and adjoining southern Illinois since 1932, the last one involving eight cases in West Salem in 1955. A Northern Section meeting was held at Lyons in December, 1957. This was primarily an exploratory meeting concerning policy matters affecting districts, such as legislative trends and needs, state aid for research and operations, and means for disseminating information. The group recognized the need for the development of a legislative program by the state association, and it was resolved that this matter should be brought before the next business session of the association.

The Fourth Annual Meeting of the I.M.C.A. was held at the University of Illinois on February 6–7, 1958, with an attendance of 70 persons, a considerable increase over the number attending last year's meeting. One of the more notable actions taken at the business session was the passage of a motion for the association to request the State Department of Public Health to employ necessary personnel to perform liaison work with mosquito abatement districts and other such interested groups, and to undertake other advisory and consultative work that might be required. Increased interest in the association is reflected in the present membership of 13 of the state's 17 districts, 105 active and associate members, and 23 sustaining members.

At the present time in Illinois there are nearly 1,000 square miles contained in organized mosquito abatement projects. The total annual budgets for abatement districts amount to more than $800,000.00, and over one and one-half million people are protected. Inquiries are frequently received from other communities, thus making it safe to assume that additional mosquito abatement districts will be formed in Illinois in the not too distant future.

OSCAR V. LOPP, Secretary-Treasurer, Illinois Mosquito Control Association.

[2] Ross, H. H. 1947. Bull. Ill. nat. Hist. Surv. 24 (Art. 1): 96 pp.

TEXAS

Until comparatively reecnt years, mosquito control in Texas has been limited largely to programs at the local level, operating through the health units. The majority of cities use adulticiding measures, consisting principally of fogging and spraying, although dusts are also used. A few communities have developed excellent larviciding programs. Many of these activities have evolved from vector control campaigns, particularly those which were focused on malaria and dengue. More recently, epidemics of arthropod-borne encephalitis in Hidalgo, Lubbock and Cameron counties have stimulated more intensive and extensive mosquito control measures in these and other areas where potential vectors are present. The epidemic in Cameron County, for example, was stopped "dead in its tracks" with effective larviciding and adulticiding measures applied to several specific foci.

During the past year, heavy rainfall in much of the state produced floods which inundated vast areas. This situation along with tremendously high tides caused by hurricane Audrey and other Gulf disturbances caused a huge increase in the overall mosquito breeding potential. In order to help meet this emergency, representatives from the Federal Civil Defense Administration, the U. S. Public Health Service and the Texas State Department of Health visited the affected areas and subsequently made recommendations as to the extent of emergency aid needed. As a result, the FCDA gave a total of approximately one-half million dollars to several Texas counties during the past year. This financial assistance proved invaluable and enabled the coastal areas to hold populations of salt-marsh mosquitoes to a minimum level.

Legal recognition was given in 1949 to the fact that mosquitoes pose a threat to the health of the citizens of this state. The 51st Legislature at its Regular Session provided for the creation, regulation and financing of mosquito control districts. Unfortunately, this enabling legislation included only those counties which border on the Gulf of Mexico. The recent serious epidemic of mosquito-transmitted encephalitis in the Lubbock-Plainview area has re-emphasized the need for an amendment to our present law so that any Texas county might establish a mosquito control district.

The first mosquito control district in Texas was set up in Jefferson County in 1950, followed a few years later by Galveston County. At this time, interest in mosquito control at the county level had increased to the point where representatives of Galveston, Brazoria, Orange, Chambers and Jefferson Counties met in 1955 and organized the Gulf Coast Mosquito Control Association. One of the principal aims of this association is to interest and assist other coastal counties in forming control districts. This organization has had three annual meetings, the most recent one (1957) being held in Corpus Christi, Texas in an effort to develop further interest in mosquito control in Nueces County. At the present time, the four adjacent counties of Brazoria, Galveston, Jefferson and Orange have active control districts. It is hoped that in the near future all the coastal counties will likewise have organized control programs. This is particularly important from the point of view of the tremendous flight range of *Aedes sollicitans,* our principal salt-marsh species, allowing inter-county dispersal from a given focus.

Representatives from certain Louisiana parishes bordering on Texas have participated in recent meetings of the Gulf Coast Association since most of their control problems are shared by Texas. Subsequently, the Louisiana Mosquito Control Association was formed. It is felt that this is another important step in coast-wide control of salt-marsh mosquitoes along the Gulf Coast.

The Texas State Department of Health encourages the control of both pest and vector species by providing information, training seminars and technical assistance. However, one of the greatest needs is for a thorough, long-range research program which would allow extensive investiga-

tions into the biology and ecology of pest mosquitoes as well as disease vectors. For the time being, control districts must direct their attention to the more practical matters at hand, providing the greatest possible protection from mosquitoes with the limited funds available. Fortunately, the problem of insecticide resistance does not appear to have reached significant proportions in Texas. This is a matter which will undoubtedly be encountered as more and more of the state comes under control. In the meantime, we are looking forward to continued growth and progress towards the distant goal of state-wide mosquito control.—DON W. MICKS, Laboratory of Medical Entomology, The University of Texas Medical Branch, Galveston.

CALIFORNIA

California, comprising most of the western coast, is one of the fastest growing areas in the United States. Its population of 14 million is increasing by one every 50 seconds or 600,000 new residents every year. To provide living space for this rapidly increasing population, the established communities, having burst their seams are spreading widely into the adjacent farming areas, in which new communities are also mushrooming. Industry, striving to keep pace, is also encroaching upon farm and marginal land.

To feed this huge, growing population and to replace lost acreage, agriculture is of necessity expanding into new areas. Today, 7 million acres are under irrigation, and plans are in the making to provide irrigation water to an additional 13 million acres of farm land, as well as water service to an additional 2½ million acres of urban, suburban and industrial areas. This current expansion and continuing increase in the use of water is in turn increasing the magnitude and complexity of the mosquito control problem. Last year, California's 45 mosquito abatement districts and 8 pest abatement districts required nearly 4 million dollars to carry on their programs.

This second largest state which stretches north and south as far as from Boston to Charleston may be divided into six major mosquito problem areas:—mountainous, coastal, northern central valley, southern central valley, southern and semi-tropical. Each of these areas has some species, habitat and problem differences. Therefore in order to give you a brief overall picture of mosquito control in California it is necessary to generalize.

The level of control in most districts is steadily improving as shown by light trap records, service requests and by the sensitivity of the population to fewer numbers of mosquitoes.

During 1957 mosquito-borne encephalitis and malaria were minimal. This past winter's abundance of rain and relatively mild weather, may provide the necessary conditions and stimuli for increased mosquito production, and this may in turn result in an increase of encephalitis.

Last year the northern portion of the Central Valley experienced the heaviest production of *Anopheles freeborni* in many years. The numerous overwintering adults, mild weather and abundance of rain may easily result in a difficult control problem during 1958.

As a result of a greater acceptance of parathion, most of the districts used some parathion during 1957; a number of these districts used it exclusively for general field spraying, both by air and ground application, and used malathion and DDT for urban and suburban control. Other districts are still using DDT, malathion and other insecticides successfully for field control. To date no mosquito resistance to parathion has been noted. Resistance to other insecticides is variable from district to district. One district which has reported some resistance by *Culex tarsalis* to malathion in 1956 subsequently reported no significant resistance during 1957.

There is a growing interest in herbicides based on the experience that adequate larval control cannot be obtained unless the

weed cover is at a minimum. During 1957 Dalapon and amino triazole were used quite extensively, and the new material Simazin is currently attracting interest for use during 1958.

There has been little if any increase in the use of legal procedures to enforce control or to require the mosquito producer to pay part of the costs of control, other than his normal tax. In the past several of the Central Valley Districts have attempted to use legal procedures but the agricultural influence in this region, greatly surpassing that of the urban and suburban population, necessitates calculated caution.

Source reduction, recognized as the ultimate solution to the mosquito control problem, is receiving increasing emphasis. A number of the districts are employing specialized technical and professional personnel for this purpose with somewhat slow but gratifying results. Other districts are using various members of their personnel for this educational and persuasive method which through the improvement of agricultural methods and industrial practices reduces and eliminates mosquito habitats.

The ingenuity, experimentation, and research by the districts individually and in cooperation with Bureau of Vector Control of the California State Health Department, the universities and colleges, the U. S. Department of Agriculture, and the U. S. Public Health Service, during the last decade has provided new concepts, methods and insecticides. The acceptance and use of many of these concepts, methods and insecticides has resulted in the present high level of mosquito control in California. Today the increasing magnitude and complexity of the problem and the constant striving for its more efficient and economical solution is resulting in an increased demand for more basic and applied research.—Robert F. Portman, President, California Mosquito Control Association, Inc.

OREGON

Prior to 1950 the only mosquito control work carried on in Oregon was by the City of Portland in the Columbia River area. From 1950 to the present time, twenty-one programs have been set up throughout the state. These vary from large programs, such as the one existing in the City of Portland areas, to smaller programs with an annual expenditure of $50 to $75.

At the present time there are only three methods under which control programs can be set up under Oregon law. The first would be the mosquito control districts, which are limited by law to counties having a population of 100,000 or over. This law would limit mosquito control districts to three counties in the State of Oregon. The second law authorizes county courts to set up mosquito control districts if the necessity should arise. This would allow the creation of organized mosquito control within any county in the state. The third law, enacted by the 1957 legislature, gives the power to sanitary districts formed under the Metropolitan Sewage District Law to carry on mosquito control activities. As noted by the above laws, the only way a continued budget can be assured is under the Sanitary District Law and the Mosquito Control District Law. The law allowing county courts to set up mosquito control programs varies from year to year according to the amount of money budgeted to support such programs, as these moneys are derived from the general budget. Thus, hardship is enacted on those working in programs that are established under county statutes.

Oregon has four climate and geographical regions with distinctive species of mosquitoes as the main pest mosquitoes. The four districts can be divided into the Coastal; the Willamette-Umpqua-Rogue River Valleys; the mountain areas; and, the irrigated areas in eastern and central Oregon. Breaking these down into species

and problem mosquitoes in these areas are as follows:

(1) Coastal Area—In the coastal area, climate is moist with a high rainfall and moderate temperature. The most troublesome mosquito is *Aedes dorsalis,* a salt-marsh mosquito prevalent in all of the salt marshes along the coast. *Anopheles occidentalis,* and *Anopheles punctipennis* are also prevalent in this area. Among the permanent water mosquitoes are *Culex tarsalis, Culex pipiens, Culex stigmatosoma, Culiseta incidens,* and *Culiseta maccrackenae.* These occur in numbers to be of local importance. Other species that may be found in the coastal area are *Aedes aboriginis* and *Culex territans.* The population increase along the coastal area of Oregon has brought about settlement of areas where mosquito problems have existed in the past, but were not of economic importance. By the result of economic and population pressures, mosquitoes have become a serious public health problem. The location of log ponds adjacent to the city center population has brought about a problem in mosquito control which has been and will be difficult to solve.

(2) Willamette-Umpqua-Rogue River Valleys—The western river valley areas are mainly concerned with permanent water mosquitoes. *Culex tarsalis, Culex pipiens, Culex territans,* and *Anopheles freeborni* are present in sufficient numbers to be of economic importance. *Aedes sticticus, Aedes varipalpus* and *Aedes increpitus* are serious pests in some localities. The main mosquito problem is the control of mosquitoes in the log ponds and polluted drainage waters.

(3) Mountain Area — The mountain area of Oregon has tremendous numbers of snow water *Aedes* which hamper the development of recreational facilities within the national forests. Control methods other than on a localized basis are not economically feasible.

(4) Irrigated Areas—The irrigated areas of eastern Oregon have a predominance of *Aedes dorsalis, Aedes nigromaculis, Aedes fitchi, Aedes intrudens, Anopheles freeborni, Culex tarsalis,* and *Culiseta incidens.* All of the above species are at times prevalent enough to be of serious economic importance. *Aedes dorsalis* and *Aedes nigromaculis* are prevalent to the extent that the social, recreation, and work patterns of many of the small communities have been seriously changed or hampered.

Other problem areas within the state which are not considered universal enough to be a state-wide problem are the Columbia River flood plain areas where *Aedes sticticus, Aedes vexans,* and *Aedes sierrensis* are the most prevalent and troublesome of the species.

In Oregon, two mosquito-borne diseases that have in the past been considered endemic are encephalitis and malaria. In the Willamette Valley malaria has historically been a mosquito-borne disease of considerable importance. Records at the Oregon State Board of Health show that the average annual morbidity for the years 1932 through 1943 was 38 cases with a high of 67 cases occurring in 1936. Occasional cases of malaria have been reported in recent years, but a true picture of local transmission is not available because of the high influx of migratory labor during the season of greatest mosquito activities. Since *Anopheles freeborni* is present throughout the state in both the irrigated eastern section and the Willamette Valley there is a potential for the recurrence of malaria within these areas. The change of environment and humidity in the irrigated areas represents a potential threat for the establishment of malaria. Thirty-three percent of all adult mosquitoes taken in resting collections from irrigated areas were *Anopheles freeborni.*

Encephalitis, which is endemic throughout the state but is concentrated in the eastern irrigated sections, can explode to the position of a serious epidemic at any time. *Culex tarsalis* is present throughout the state and the reservoir is established as indicated from sera samples taken from horses and chickens throughout eastern Oregon. In 1956 there were 54 horse

cases of western equine encephalitis in two counties in the endemic area. No reported human cases occurred, which is a mystery to us. As the population increases in these areas, susceptibles coming into the area will be exposed to the disease and a rise in encephalitis should be considered imminent. Until proper irrigation methods are practiced as well as the control of log pond mosquitoes, encephalitis will be a potential hazard in the endemic areas.

Another problem that exists within Oregon as more land comes under irrigation and as the population increases, is *Culicoides*. We have a problem at present in some of our coastal recreation areas, as well as in the irrigated areas of eastern Oregon. The development of sewage lagooning in the more arid part of the state will tend to increase the *Culicoides* problem if proper maintenance is not carried out in sewage lagoons. A reported outbreak of blue tongue among sheep in one of our counties has shown that the potential vector is present in the eastern Oregon area.

To date, resistance to DDT among the mosquitoes has been reported from only one locality—this being in a heavily polluted log pond. An interesting sidelight to this occurs in the Portland area during July and August when the water temperatures are up in the smaller ponds. DDT applied during midday has been failing to provide control of mosquito larvae, whereas re-treatment or treatment during the early morning hours when the water temperature is lower, has resulted in excellent control of larvae. Reported occurrences of insecticide resistance have been investigated and in most cases improper application of the insecticides has been responsible for the decrease in mortality of the larvae rather than resistance to the insecticide.—L. S. Miller.

WASHINGTON

We hope the year 1957 will pass as an important transition period in the history of mosquito control activities in the State of Washington. At least three outstanding developments occurred during the year which should give renewed interest in fighting mosquitoes within the state.

The control of mosquitoes in various counties of the State is not new. In fact, there have been mosquito control programs to a greater or lesser extent in several of the counties for the past 30 years. There have been several attempts also to obtain enabling legislation during the past 20 years but not until March, 1957 was the Act passed by the Washington State Legislature. The Enabling Act now authorizes the organization of mosquito control districts, when favorably voted by the counties, in seven counties of the Columbia Basin, in eastern Washington. These are Adams, Benton, Franklin, Grant, Kittitas, Yakima, and Walla Walla counties. Undoubtedly the periodic epidemics of encephalitis are responsible for accelerating this interest in fighting the mosquito pest and also promoted the concerted effort of the State Department of Health and interested citizens in going to the State Legislature for the needed law.

The State Department of Health employed a full-time entomologist for the first time on July 25, 1957, to assist the counties in implementing the enabling legislation. The usual pros and cons for mosquito control were heard in the seven counties, and in at least one county bitter opposition was observed. Meanwhile one of our most important courses of action is to acquaint the public with mosquito biology and economics.

Three of the seven counties, Adams, Benton, and Franklin, voted on the organization of districts and on the levying of taxes to finance their work. Unfortunately, in each instance too few votes were cast to provide the necessary funds. The Benton County Mosquito Control District Board of Trustees met in Pasco, December 3. This was the first meeting of a Mosquito Control District Board of Trustees to be held in the state. (Only about one third of the county was included in the

district.) Dr. Robert C. Pendleton, a member of the American Mosquito Control Association and formerly of the Salt Lake City District, was elected President of the Board. The first meeting of a county-wide Mosquito Control District Board of Trustees occurred in Lind, Adams County on December 9. Mr. Maynard Jensen was elected President of the Adams County Mosquito Control District Board of Trustees.—HARRY H. STAGE, Entomologist, Washington State Department of Health.

NEBRASKA

The year 1957 was important in the history of mosquito control in Nebraska. The 1957 session of the Nebraska Legislature passed Legislative Bill 378, an act relating to mosquito abatement districts and their formation. On May 4, 1957, Governor Victor E. Anderson signed the bill and it became a law under the Emergency Clause.

Unfortunately, the Nebraska mosquito abatement law has the undesirable feature of requiring a vote of "55 percent of the electors of the district, as determined by the number of votes for Governor at the last general election in the proposed district." At the present time we do not know whether or not this will be an insurmountable problem. On February 5, 1958, there was organized at Bayard, Nebraska, the North Platte Valley Mosquito Abatement Association, whose objective is to organize a mosquito abatement district in Gorden, Morrill, and Scottsbluff counties. It is the hope of this organization that they can have an election for a mosquito abatement district held in conjunction with the general election this coming November. If the people vote in favor, they will then be able to have a mosquito abatement district by late 1959 or early 1960.

In many respects 1957 was one of the worst mosquito years in a long time. For the past several years, Nebraska has been suffering from a drought, which finally broke in the spring of 1957. Heavy rains in May and June resulted in flooding in all areas of the state. This resulted in an almost state-wide *Aedes vexans* problem. This problem continued well into the summer and as the season went along, large populations of *Culex tarsalis* and *Aedes dorsalis* and other species developed. In the North Platte Valley the mosquito populations reached such proportions that it was difficult to obtain labor for the sugar beet fields. Since sugar beets are the best cash crop in the valley, it is the general opinion that some type of control program must be started.

During the past year over one hundred municipalities in the state had some type of mosquito control program. Unfortunately, the majority of these programs are run on a hit or miss basis. It would appear that in many cases the psychological results outweigh the entomological results. Twenty-seven municipalities submitted data to us on their 1957 program and these 27 municipalities spent $10,013 for insecticides alone. The reasons why good results are not achieved are many. Lack of proper know-how is probably the number one problem. Many municipalities do not realize the importance of using trained personnel to head up their program. Usually they wait until the last minute and select some city employee and add the spraying work on to the rest of his work. Poor selection of insecticides is often to blame. High pressure salesmanship, desire to do business with the local business man is often responsible for the selection of the wrong insecticides. Another reason for lack of success is the improper choice of equipment. In some municipalities they attempt to use existing equipment such as fire trucks equipped with fog nozzles, weed sprayers, etc. In some cases we can again blame over-ambitious salesmen. Unfortunately, at the present time the majority of municipalities are devoting all of their efforts to adult control and none to source reduction.

The State Department of Health, for the

past five years has been carrying on an educational program. Each year a list of recommended insecticides is published and distributed to all municipalities which are carrying on insect control programs or which are interested. Also a series of meetings have been held in the spring of each year. Unfortunately, the majority of these meetings have been poorly attended.

At the present time encephalitis is the only mosquito-borne disease in Nebraska. Although we have for years considered St. Louis encephalitis as endemic in eastern Nebraska, recently we have been able to demonstrate serologically that St. Louis encephalitis occurs throughout the state. Since *Culex pipiens* is of minor importance it is thought that *Culex tarsalis* is the principal vector in Nebraska.—William F. Rapp, Jr., Entomologist, State Department of Health, Lincoln, Nebraska.

THE MOSQUITOES OF THE INTERNATIONAL AIRPORT, ISLA VERDE, PUERTO RICO, AS SHOWN BY LIGHT TRAPS

IRVING FOX [1]

School of Medicine—School of Tropical Medicine, University of Puerto Rico, San Juan, P. R.

The Puerto Rico International Airport is among the most important in the world, accommodating almost a million passengers a year (Gotay Montalvo, 1957). It is located about seven miles to the east of the Old City of San Juan on the north coast, in an area of great natural beauty and of high recreational value, where new housing developments and luxurious hotels are being constructed at a rapid rate. But this is a region of largely undeveloped land including many acres of saltmarsh which breed mosquitoes and sand flies in enormous numbers. The airport cost $16,000,000 to construct and property values in the environs and equipment, including that of an important Air National Guard base, would give a figure several times this amount as the total value of the area; nevertheless no significant part of the huge sums spent for construction go for insect control, despite the magnitude of the mosquito problem there. Since inauguration on May 22, 1955, popular clamor has been great that something be done about the mosquitoes and sand flies, but repeated attempts to secure an adequate appropriation by legislative action have so far been unsuccessful.

Despite the handicaps of an inadequate budget, it was possible to accomplish certain aspects of the survey work which is essential to control by limited use of personnel and equipment of the various interested agencies; in particular the gathering of data by light traps was feasible. Several of these were in operation by the U. S. Public Health Service before this project began. Others were added and the collections carefully studied with the following objectives: (1) To find out what species occur in the area and their relative abundance; (2) to ascertain any consistent seasonal variation of the pest species; (3) to obtain population data which may be used to gauge the effectiveness of control measures should they ever be instituted in the future; and (4) to obtain information on disease hazards.

[1] In cooperation with Félix C. García and Manuel Pérez Torres, Puerto Rico Department of Health; Dr. Marvin S. Cashion, U. S. Public Health Service; and O. L. Sands, Puerto Rico Ports Authority. Portions of this study were supported by the Puerto Rico Department of Health. Other portions were supported by Research Grant E-1225, from the National Institute of Allergy and Infectious Diseases, Public Health Service.

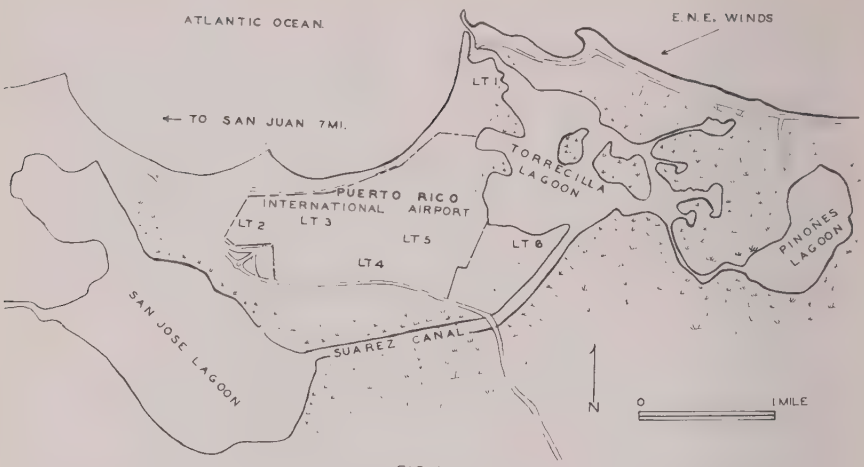

FIG 1

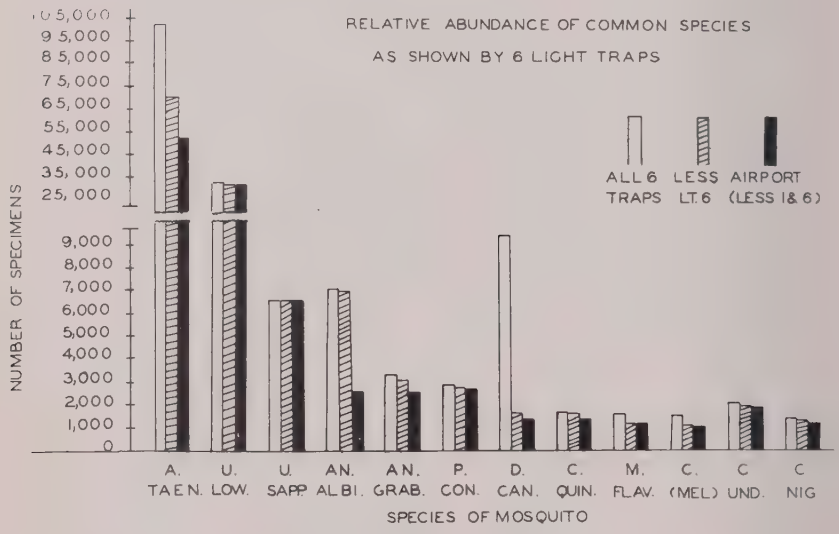

FIG. 2

FIG. 1.—Map of the International Airport and vicinity, Isla Verde, Puerto Rico.

FIG. 2.—Relative abundance of *Aedes taeniorhynchus, Uranotaenia lowii, Uranotaenia sapphirina, Anopheles albimanus, Anopheles grabhamii, Psorophora confinnis, Deinocerites cancer, Culex quinquefasciatus, Mansonia flaveola, Culex* (*Melanoconion*) species, *Culex* undetermined species, and *Culex nigripalpus* as shown by six light traps in 2,733 trap-nights during the period January 1, 1956 to December 30, 1957 at the International Airport and vicinity, Isla Verde, P. R.

Six New Jersey type light traps were operated, using 40 watt light bulbs. Four of the traps were within the fenced grounds of the airport proper (about 1200 acres) and two in the near vicinity; their locations are indicated on the map, Figure 1. The light traps were designated as follows: Lt. 1, Yacht Club (about a mile to the northeast of the airport limits at Boca de Cangrejos); Lt. 2, Maintenance Area (inside the fenced area of the airport proper but some distance to the west of the main buildings); Lt. 3, Terminal (airport proper); Lt. 4, Transformer (airport proper); Lt. 5, Water Tank (airport proper); and Lt. 6, International Park (a recreation area about a mile to the east of the airport on the shores of Torrecilla Lagoon). Various difficulties prevented the operation of one or the other of the traps at various times; however, from January 1, 1956 through December 30, 1957 the traps were run for a total of 2,733 trap nights. Except for Light Trap 6, the traps were operated more or less regularly during the two year period and the trap nights they functioned during each month are shown in Table 1.

A total of 176,053 mosquitoes were captured and identified. *Culex* males were all determined on the basis of the male terminalia, but most of the *Culex* females had to be counted either as "*Culex* undetermined" or "*Culex* (*Melanoconion*) species." The members of the other genera were determined using external characteristics. *Uranotaenia* and *Deinocerites* were not separated into males and females. In all, 26 species were encountered or about three-fourths of those known to occur in Puerto Rico and more than have ever been taken in light traps at any other place in the Island (Tulloch, 1937; Pritchard and Pratt, 1944; Fox, 1953; Fox and Maldonado-Capriles, 1953). The species captured in order of abundance of specimens are

TABLE 1.—Months of operation and trap-nights for each light trap at the International Airport and vicinity, Isla Verde, Puerto Rico, in 1956 and 1957

Month	Lt. 1	Lt. 2	Lt. 3	Lt. 4	Lt. 5	Lt. 6	Total
1956:							
January	31	0	0	0	0	0	31
February	14	20	27	11	16	0	88
March	24	29	27	10	30	0	120
April	32	32	18	31	31	0	144
May	24	31	0	31	31	0	117
June	27	30	0	30	30	0	117
July	30	23	0	21	26	18	118
August	27	27	0	32	17	0	103
September	29	22	0	29	29	0	109
October	28	32	0	29	29	0	118
November	23	26	0	8	30	0	87
December	29	28	0	17	28	0	102
1957:							
January	33	30	30	33	32	0	158
February	28	25	28	28	25	0	134
March	30	30	21	30	23	0	134
April	31	31	31	31	5	22	151
May	31	32	32	32	0	32	159
June	24	24	24	24	0	24	120
July	37	37	35	35	0	0	144
August	34	26	29	29	0	0	118
September	18	22	22	22	0	0	84
October	33	11	36	33	0	0	113
November	22	0	30	30	0	0	82
December	27	0	26	29	0	0	82
Total	666	568	416	605	382	96	2,733

TABLE 2.—Relative abundance of mosquitoes taken in light traps at the International Airport and vicinity, Isla Verde, Puerto Rico, in 1956 and 1957

Species	Females	Males	Total
Aedes taeniorhynchus (Wied.)	100,698	3,099	103,797
Uranotaenia lowii Theob.			32,740
Deinocerites cancer Theob.			9,649
Anopheles albimanus Wied.	6,786	183	6,969
Uranotaenia sapphirina (O.S.)			6,689
Anopheles grabhamii Theob.	2,740	648	3,388
Psorophora confinnis (L.A.)	2,194	605	2,799
Culex undetermined	1,896		1,896
Culex quinquefasciatus Say	892	713	1,605
Mansonia flaveola (Coq.)	878	603	1,481
Culex (*Melanoconion*) species	1,398		1,398
Culex nigripalpus Theob.	717	549	1,266
Culex atratus Theob.	14	839	853
Aedes tortilis (Theob.)	312	38	350
Anopheles vestitipennis D. & K.	277	70	347
Aedes sollicitans (Walk.)	280	12	292
Culex opisthopus Komp	56	125	181
Culex erraticus (D. & K.)		155	155
Culex habilitator D. & K.	4	61	65
Culex iolambdis Dyar		64	64
Culex sardinerae Fox		15	15
Uranotaenia cooki Root			14
Culex chidesteri Dyar		13	13
Psorophora pygmaea (Theob.)	13		13
Aedes aegypti (Linn.)	4	3	7
Culex bahamensis D. & K.		4	4
Culex pilosus (D. & K.)		2	2
Culex americanus (N.-L.)		1	1
Aedes mediovittatus (Coq.)			0

listed in Table 2. Included therein is *Aedes mediovittatus,* previously captured by other workers (Pritchard and Pratt, 1944), bringing the total taken by light traps operated in the airport and vicinity to 27 species. Ten species: *Ae. taeniorhynchus, U. lowii, D. cancer, Anopheles albimanus, U. sapphirina, An. grabhamii, Psorophora confinnis, C. quinquefasciatus, Mansonia flaveola* and *C. nigripalpus,* provided more than 95 percent of all the specimens taken. Light traps 1 and 6 were located outside the fenced area of the airport proper and Figure 2 shows graphically the relative abundance of the common species counting and not counting the results from these two light traps; when these two traps are eliminated the difference in relative abundance is significant only as regards *An. albimanus* and *D. cancer.* Light trap 6 was located nearest to the main breeding places of *Ae. taeniorhynchus* in the swamps to the east of the airport, and many more mosquitoes would have been collected had it been possible to operate this light trap as regularly as the others. As it was, in only 96 trap-nights, this light trap yielded about 30 percent of all the specimens of *Ae. taeniorhynchus* collected. The counts were as follows: July, 1956, 2,133 specimens; April, 1957, 501; May, 1957, 7,604;

FIG. 3.—Monthly average of *Aedes taeniorhynchus* per light trap-night for four light traps (Light traps 1, 2, 4, and 5), shown in solid lines, and the monthly rainfall in inches, shown in broken lines, 1956 and 1957, International Airport and vicinity, Isla Verde, Puerto Rico.

FIG. 4.—Monthly average of *Anopheles albimanus* per light trap-night for four light traps (Light traps 1, 2, 4, and 5), shown in solid lines, and the monthly rainfall in inches, shown in broken lines, 1956 and 1957, International Airport and vicinity, Isla Verde, Puerto Rico.

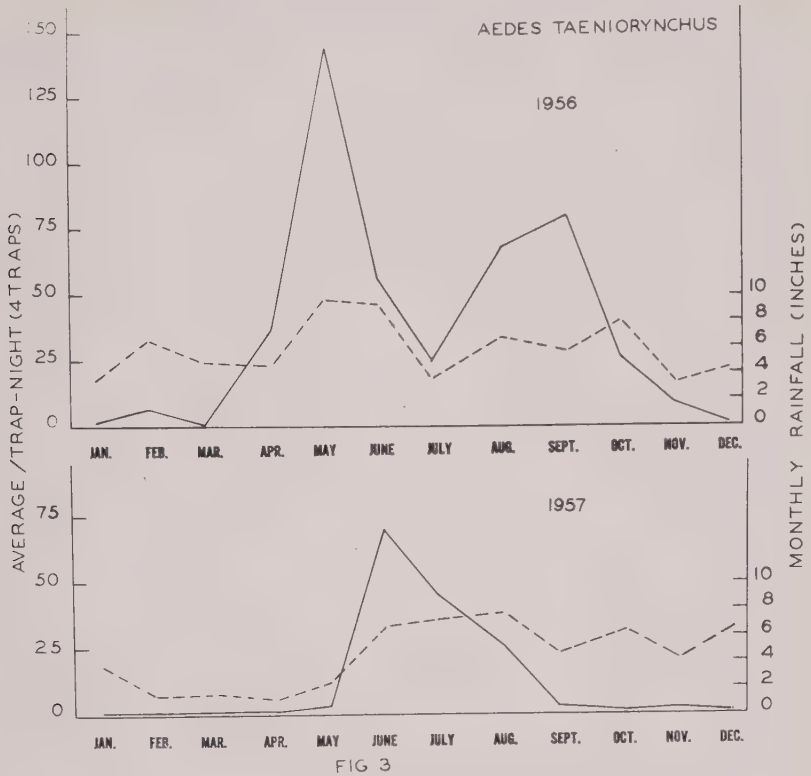
AEDES TAENIORYNCHUS
1956
1957
AVERAGE /TRAP-NIGHT (4 TRAPS)
MONTHLY RAINFALL (INCHES)
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

FIG 3

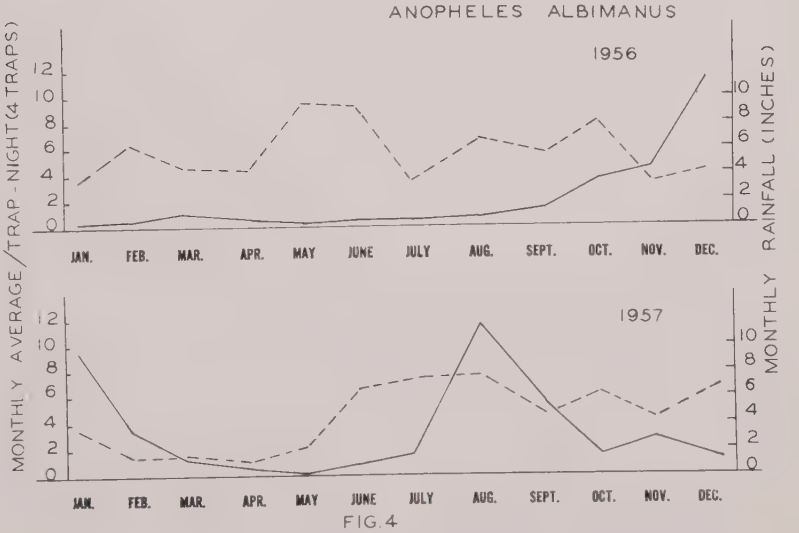
ANOPHELES ALBIMANUS
1956
1957
MONTHLY AVERAGE /TRAP-NIGHT (4 TRAPS)
MONTHLY RAINFALL (INCHES)
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

FIG. 4

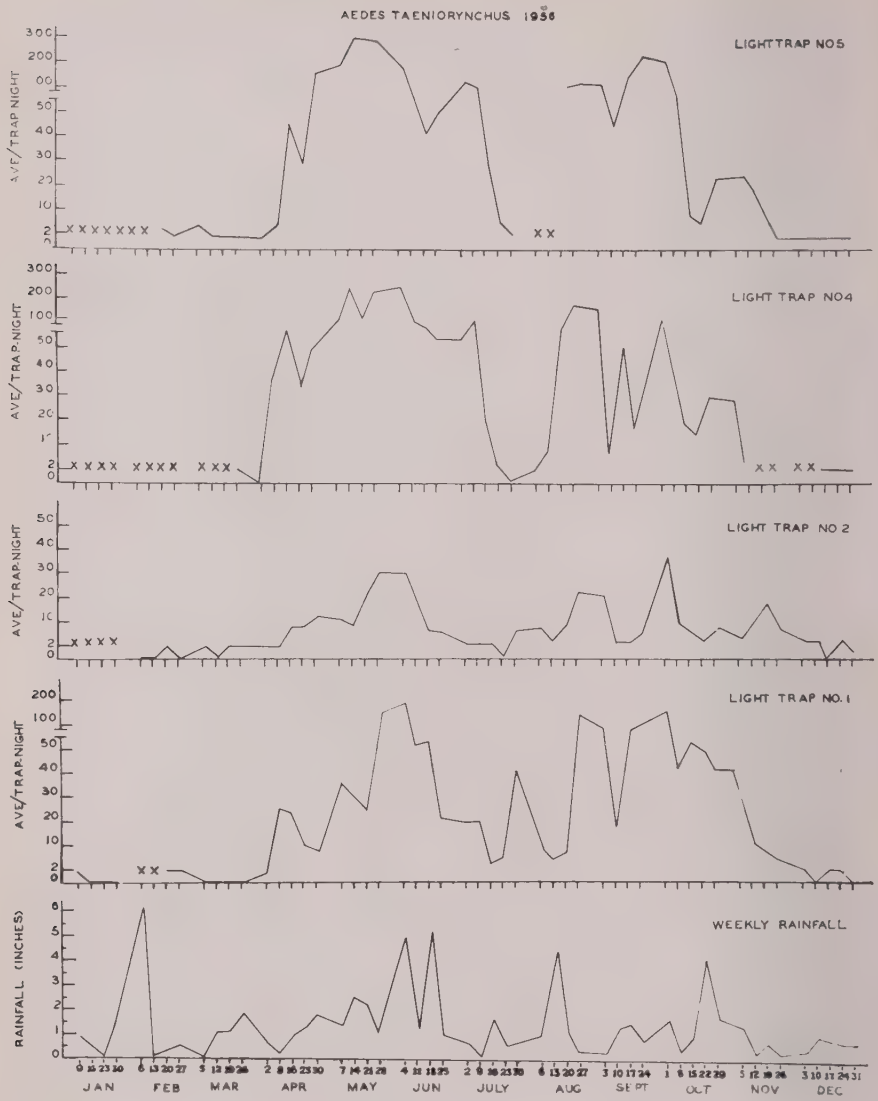

FIG 5

FIG. 5.—Weekly average per light trap-night of *Aedes taeniorhynchus* for each of four light traps (for 2 read "2 or less"; and the letter "x" indicates that the light trap did not operate), compared with the weekly rainfall in inches at the International Airport and vicinity, Isla Verde, Puerto Rico, in 1956.

June, 1957, 24,102 (for the trap-nights see Table 1). On the other hand, light trap 2 was located farthest to the west away from the main breeding places and in the whole two year period in a total of 568 trap-nights only 3,051 specimens were taken. The light traps were eminently successful in providing worthwhile population data on *Ae. taeniorhynchus,* undoubtedly the main pest mosquito; but they failed entirely to give an indication of the abundance of *Ae. sollicitans* which occurred in very few numbers in the traps, although biting viciously in their vicinity. Nor is the data reliable as regards *C. quinquefasciatus,* which is probably much more abundant than indicated by the light traps.

The north coast of Puerto Rico has a very mild climate usually with temperatures from 70° to 90° and rainfall from 50 to 70 inches annually. Monthly rainfall may be quite variable from year to year, yet typically there are two rainy seasons with peaks in late spring or summer and again in the fall. During 1956 precipitation was heavy with 69.61 inches recorded at the airport; peak rainfall of about 9 inches occurring in the months of May, June, and October. In 1957 there was much less rainfall, 53.01 inches for the year, with very dry weather from February through May. The monthly average of *Ae. taeniorhynchus* for four light traps (light traps 1, 2, 4, and 5) was calculated and the results are shown graphically in Figure 3. Many more specimens were taken in the year of greater rainfall, 1956 than the one of lesser rainfall, 1957. In 1956 *Ae. taeniorhynchus* showed peaks and recessions of abundance which seemed to follow the monthly rainfall, but in 1957 it was abundant in the light traps only in the summer months, and there was no increase in mosquitoes corresponding to the second peak of rainfall in the late fall. From these data we may conclude that the abundance of *Ae. taeniorhynchus* will vary from year to year depending upon the rainfall and that it is most abundant from April to October of each year. The 1956 weekly average per trap-night was calculated for these same light traps and the results are shown graphically in Figure 5. The light traps are consistent in showing periods of abundance and scarcity even though certain traps yielded many more mosquitoes than others, indicating that the phenomenon is general. Comparison with the weekly rainfall seems to indicate that a sudden heavy precipitation does not influence the mosquito counts, rather it is high levels of rainfall over relatively long periods of time which result in an increase in the mosquitoes. Rainfall is of great importance, but undoubtedly other factors influence the seasonal variation of *Ae. taeniorhynchus.* The monthly average per trap-night of *An. albimanus* for the same light traps was also compared with the monthly rainfall and the results are given graphically in Figure 4. This species did not show any consistent seasonal variation or relationship to rainfall from year to year.

In Puerto Rico at the present time active transmission of pathogenic organisms by mosquitoes is not a serious problem with the possible exception of filaria. The main vector of filaria, *C. quinquefasciatus* is common, and in view of the rapid growth of housing developments in the vicinity of the airport with concomitant flood water and sewage disposal problems, this species will become as serious a pest here as it is throughout the Island. However, filariasis is a disease which is most prevalent inside institutions such as prisons and asylums where more or less permanent sources of infection exist (Maldonado, *et al.,* 1948). Malaria was formerly a disease of great public health importance in Puerto Rico, but it is now eradicated from the Island, although a few cases occur each year from transients (Puerto Rico Bureau of Malaria and Insect Control, 1955). The vector, *An. albimanus* is sufficiently abundant near the airport at certain times to cause an outbreak of the disease if the mosquitoes became infected. Yellow fever has not occurred on the Island for more than 50 years, although *Ae. aegypti* has

been fairly common. An eradication program began in 1950 by the Department of Health is in progress, but because of an inadequate budget it is not completely effective and considerable strengthening is required (Fehn and Hayes, 1956). In 1956 a recrudescence in population of this species occurred in the San Juan area and breeding places were found in the airport. Therefore, there is a hazard based on the possibility of the disease being introduced by an airplane passenger. There is little hazard from dengue, also transmitted by *Ae. aegypti,* for the last outbreak took place several decades ago (King, 1917) and the disease does not appear to occur in Puerto Rico today. The danger from mosquito-borne virus encephalitides is not known, as this group of diseases has not been reported from the mainland of Puerto Rico although it has been found on nearby islands. From a practical point of view the mosquitoes of the airport are of more importance as pests than as vectors of disease and in many persons their bites cause allergic reactions of varying severity. This is a more serious problem than is generally realized, and investigations are under way to ascertain the extent and intensity of the reactions, their specificity and immunological characteristics.

SUMMARY AND CONCLUSIONS. In 1956 and 1957 six New Jersey type light traps were operated at the International Airport and vicinity, Isla Verde, Puerto Rico, and in the course of 2,733 trap-nights, 176,053 mosquitoes were collected and classified. Of the 26 species of mosquitoes encountered in the light traps, *Ae. taeniorhynchus* was the most abundant. A consistent seasonal variation in abundance of this species favoring the summertime and apparently related to the rainfall was demonstrated by the light traps, and the population data obtained when correlated with climatic conditions should prove useful in measuring the effectiveness of control efforts when they are instituted. However, the light traps failed to give an indication of the true abundance of *Ae. sollicitans* and probably *C. quinquefasciatus.* Light trap counts of *An. albimanus* did not show any consistent seasonal variation from year to year. Only seven specimens of *Ae. aegypti* were taken in the two year period, but this was considered an important finding as it led to the discovery of breeding places in the airport. The hazards from mosquito-borne diseases are discussed and it is concluded that the mosquitoes of the airport are of more importance as pests and producers of allergic reactions than as vectors.

ACKNOWLEDGMENTS. Thanks are expressed to Dr. E. H. Hinman, Dean of the School of Medicine and Dr. Pablo Morales Otero of the Puerto Rico Legislature for their continuous encouragement in the work; to Dr. Alan Stone of the U. S. Department of Agriculture for checking the determinations of the species of mosquitoes, and to Mr. Víctor Medina, Mr. Francisco Romero Alemán and Mr. Víctor Villanueva for their assistance.

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MOSQUITOES AND THEIR CONTROL IN THE TERRITORY OF HAWAII

PATRICK Y. NAKAGAWA [1] AND ROBERT T. MIKUNI [2]

Hawaii has been actively concerned with mosquito control for well over 50 years. As early as 1902 *Gambusia* were introduced from Texas for mosquito control. In 1906 the Honolulu Shippers' Wharf Committee and the Hilo Shippers' Wharf Committee voluntarily provided $3,858 for a rat and mosquito campaign; mosquito control was, however, incidental to rat control, and what time could be "justly spared" from rats was devoted to mosquitoes.

Men for mosquito control work were employed by the Bureau of Sanitation in 1911, but in succeeding years mosquito control activities appear to have been carried out in a rather hit-or-miss fashion. In 1930, mosquito and rat control programs were assumed by the Public Health Committee of the Chamber of Commerce, which had been active for a number of years in promoting support for these programs. Funds were obtained for the programs by a "voluntary" tonnage tax levied upon imports.

The dengue outbreak of 1943–44 in Honolulu brought the need for mosquito control forcefully to the attention of both the Federal and the Territorial Governments. The U. S. Public Health Service, the military authorities, and others came to the assistance of the Territorial Board of Health, and an intensive mosquito control program was carried out on Oahu during 1943–44 and extending through 1945. This prompt action apparently stopped the outbreak and limited it to 1,498 human cases, whereas it might otherwise have involved many thousands of the Islands' half million population.

The last dengue case was reported in July 1945, and no military personnel were assigned to the program after November 1945. The U. S. Public Health Service assistance was also discontinued at the end of May 1946. Since that time the Territorial Board of Health has maintained a minimal mosquito control program with annual expenditures running a little over $100,000. This program was established primarily for the control of dengue mosquitoes (*Aedes*), but, as was inevitable, it has been increasingly involved with "emergency control" of *Culex*. With the apparent eradication of *Aedes aegypti* from Oahu, the program has evolved into an "*Aedes* prevention" and "*Culex* control" program.

The present Bureau which is the outgrowth of the dengue campaign has been very fortunate in having had such able leadership during 1943–1946 when the program was under Public Health Service guidance and was administered by such eminently qualified men as Mr. Wesley E. Gilbertson, Dr. R. L. Usinger, and Mr. Arve H. Dahl. Since its conversion to Territorial status in about June 1946, under the continuing able leadership and guidance of its former chiefs, Dr. David D. Bonnet and Dr. Stephen M. K. Hu, the Bureau of Mosquito Control has attained maturity and status as an important Bureau in the Division of Sanitation, Department of Health. From September 1955 to December 1957, during Dr. Hu's leave of absence, Mr. Robert T. Mikuni carried on the program as its acting administrative officer. Upon Dr. Hu's subsequent resignation to accept a position with the U. S. Naval Medical Research Unit No. 2, in Formosa, its present Chief Mr. Patrick Y. Nakagawa was appointed to fill the vacancy in January 1958.

[1] Appointed as Chief, Bureau of Mosquito Control, January 1958.

[2] Former Acting Administrative Officer and present Assistant Chief.

Fortunately, there are only three species of biting mosquitoes in Hawaii: *Aedes aegypti, Aedes albopictus,* and *Culex quinquefasciatus.*

Aedes aegypti (Linn.), the classic vector of yellow fever, is also a vector of dengue fever and a potential vector of filariasis and several forms of encephalitis. This species is highly domesticated and is much more limited than that of the other species; it is usually restricted to the warmer, drier areas of the Islands. Apparently this species has been eradicated from the Island of Oahu because repeated surveys to date have failed to uncover its presence.

Aedes albopictus (Skuse) is a proven vector of dengue fever and has also been demonstrated to be capable of transmitting yellow fever and encephalitis. This species is widely distributed in the Hawaiian Islands, being found at both low and high elevations. It is found in artificial containers along with *Aedes aegypti* but is commonly found in natural containers such as tree-holes, rock holes, and water-holding plants. The flight range of this species in Hawaii has been reported as usually less than 200 yards.

Culex quinquefasciatus Say is by far the most abundant and the most annoying of the mosquitoes in Hawaii. It commonly breeds in ground pools, swamps, and irrigation ditches, as well as in artificial containers. It is particularly abundant in waters of high organic content such as sewage effluents and run-off from pig and dairy farms. This species is a known vector of filariasis (*Wuchereria bancrofti*) in the West Indies, and has been experimentally infested in Hawaii; however, so far as is known, no case of locally acquired filariasis has been recorded. It is also said to be a potential vector of Japanese B, western equine, St. Louis, and Murray Valley encephalitis.

In addition to the three biting species, four species of non-biting *Toxorhynchites* (*–Megarhinus*) have been introduced into the Islands for biological control of *A. albopictus*: *T. inornatus* from New Britain in 1929 (probably no longer present); *T. brevipalpis* from South Africa in 1950; *T. splendens* from the Philippines in 1953; and *T. hypoptes* from Panama in November-December, 1953 (probably no longer present).

The basic justifications for mosquito control in Hawaii have been aptly summarized by Dr. A. D. Hess, Scientist Director, PHS, CDC, Technology Branch, Logan, Utah, who at the request of Dr. Richard K. C. Lee, President of the Board of Health, conducted an appraisal of the mosquito control program during January 22 to February 22, 1957. These are: (1) prevention of human disease transmission; (2) prevention of other public health nuisance; (3) prevention of the introduction of new diseases and mosquitoes into the Islands; and (4) prevention of interference with tourist trade and other economic developments. Of these four justifications, we would like to single out for special emphasis the third point, "prevention of the introduction of new diseases and mosquitoes into the Islands," not necessarily because it outweighs the other three in importance, but because it well emphasizes the important role Hawaii assumes as "stepping stones" in the prevention and introduction of dangerous vectors or vector-borne diseases into the United States. It is, therefore, essential not only to carry out disinsectization of incoming vessels and aircraft, but to conduct thorough inspections and control measures around all ports of international travel and commerce. Records reveal that since 1939, a total of 32 species of mosquitoes have been intercepted on aircraft arriving at Honolulu, including at least six species of *Anopheles.*

Mosquito breeding is a year-round problem in Hawaii because of the equable climate. The moderately tropical climate which is so tempered by the trade winds never provides a condition too hot, or too cold, or to dry, or too wet to inhibit the multiplication of mosquitoes. Consequently, mosquito abatement in Hawaii is a year-round proposition.

The scope of operation of the Bureau

of Mosquito Control is dictated by its limited legislative appropriation and must necessarily be confined to surveys, inspections, education, and temporary control measures such as larviciding and adulticiding. It has, however, always recognized as foremost, the desirability of permanent control measures and has constantly advocated such measures as filling, ditching, and water management whenever feasible.

Unless requested or on special surveys which are coordinated and cleared through channels, the Bureau's operation does not normally extend into areas under military jurisdiction. On military reservations, the Territorial program is adequately complemented by the respective control programs of the Army, Navy and Air Force in Hawaii. The strategic location of the Hawaiian Islands provides centers for numerous military commands which have conducted mosquito control programs for several years. With the new materials, insecticides and equipment which are available for mosquito control, the effectiveness of the military control program has improved considerably in recent years. These advancements in the techniques of mosquito control have established the fact that mosquito control on an island-wide basis is possible and practicable through coordinated efforts by all interested parties, civilian and military. To date, the cooperation existing among the Department of Health, the military, and interested community associations, which have voluntarily subscribed contributions to enter into the field of mosquito control, provides an optimistic view towards the realization of a concerted mosquito control program for Hawaii.

EDITORIAL

In place of a formal editorial, the editor takes this space to urge readers, especially those who are members of AMCA, to read the minutes of the last annual meeting as published on pages 150–176 of this issue of *Mosquito News*. Potential contributors especially should read Attachment No. 5, in which the rules which should be followed in preparing and submitting manuscripts are presented by Dr. Twinn, Chairman of the Publications Committee.

Doctor McDuffie's report as chairman of the Committee on Research and Development (Attachment No. 14) includes much material which if expanded could easily comprise several original papers. Most of the reports of other committees also have features of special interest and merit thoughtful attention.

ARTICLES

THE WORLD HEALTH ORGANIZATION TEST KIT FOR DETECTION OF RESISTANCE IN MOSQUITO LARVAE

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Scientist (Biologist), World Health Organization, Geneva, Switzerland

Realizing the need for standard tests for resistance in insects of public health importance, the Expert Committee on Insecticides (1957) at its seventh session in July 1956 recommended the release of a trial method for mosquito larvae based on a fusion of existing techniques as summarrized by Brown (1957). Accordingly a tentative method was drawn up with the expert advice of Dr. J. R. Busvine and Dr. R. W. Fay, and 28 test kits were distributed in May 1957 to key workers throughout the world for a practical trial and suggestions for their improvement.

This tentative method involved exposing duplicate lots of 30 larvae in the third or early fourth instar to DDT, gamma-BHC or dieldrin at 5 concentrations ascending in multiples of 5; the larvae were exposed in 1 litre of water in enamel pans for 24 hours and removed to clean water for a further 24 hours. Meanwhile a paper had appeared by Jones (1957a) describing a sensitive method based on various periods of exposure to a standard concentration of 100 p.p.m. DDT and the determination of a median lethal time (MLT); this was similar to the principle utilized by Burchfield, Hilchey and Storrs (1952) of determining the period of exposure (T_{50}) causing 50 percent of the larvae to lose their negative phototropic response. Moreover Elliott (1957) was using a method based on 1-hour exposure to graded concentrations, followed by a 5-hour recovery period, to counteract the control mortality shown by sensitive species such as *Anopheles gambiae*.

The WHO tentative method was submitted to practical trial by Smith and Ford (Florida), Fay (Georgia), Lewallen (California), Blazquez (Venezuela), Floch and Fauran (French Guiana), Busvine (England), Gad (Jordan), Gramiccia (Iraq) and Armstrong and Bransby-Williams (Tanganyika). They reported favourably on the method and kit, while making certain suggestions for their improvement, and the results of the tests they made are available from the World Health Organization (1958). In addition, valuable comments were received from Gjullin (Oregon), Hawkins (Alabama), Bunn (Washington, D. C.) and Elliott (Nigeria). A most detailed and valuable series of evaluation tests was performed at the National Institutes of Health by Jones (1957); and the WHO tentative method was compared by Dews (1957) with the Orlando test method as currently employed by the Armed Forces.

The results gained during this trial period were reviewed in November 1957 by the Expert Committee on Insect Resistance and Vector Control (1958). Since it had been shown by Jones (1957b) that the size of the container had no effect on the LC_{50} levels in third instar larvae of *A. quadrimaculatus,* the volume of water recommended was reduced to 250 cc; since he had found the size of the test group to make no marked difference in the results, the number of larvae was reduced to 20–25 with an option of 10 in cases of scarcity. On the recommendation of the Orlando workers and the U. S. Army authorities, the containers were changed to glass vessels. Since transfer of the larvae to clean water for a second day greatly increased the control mortality, the

observation period was restricted to 1 day. Since the 24-hour control mortalities by this method were more frequently zero than not, even failing to exceed 12 percent with *A. gambiae,* it was considered that a shorter period of exposure should not be recommended for the standard method, although it might prove necessary for certain species of *Anopheles.*

The test kit weighs 2½ lbs. and measures 8 inches in length, 5 inches in width and 5½ inches in height (Fig. 1). The standard test method as drawn up by the Expert Committee on Insect Resistance and Vector Control is as follows:—

Instructions for Determining the Susceptibility or Resistance of Mosquito Larvae to Insecticides

Introduction

(a) In order to detect the emergence of an insecticide-resistant strain of a mosquito, it is necessary to have either basic data for the species before the wide use of insecticides or else to make comparisons with specimens from an untreated area. Where regular larvicide operations are undertaken to control mosquitoes, the normal susceptibility levels of the larvae should be determined as early as possible. To this end, several tests (a minimum of eight) should be performed at various localities and seasons, to assess normal biological variation.

(b) It is suggested that the tests be continued at regular intervals to determine any significant reduction in susceptibility. It appears that resistance may be suspected in mosquito larvae if there is an increase of 10–50 times over the original LC_{50}, or when a proportion of the population can no longer be killed by any of the available concentrations. From the comparatively small amount of data available at present, the indications are that when an LC_{50} for DDT in excess of 0.1 p.p.m. is found for *Aedes* or *Anopheles,* or an LC_{50} above 1 p.p.m. for *Culex,* resistance should be suspected.

(c) The previous history of the use of

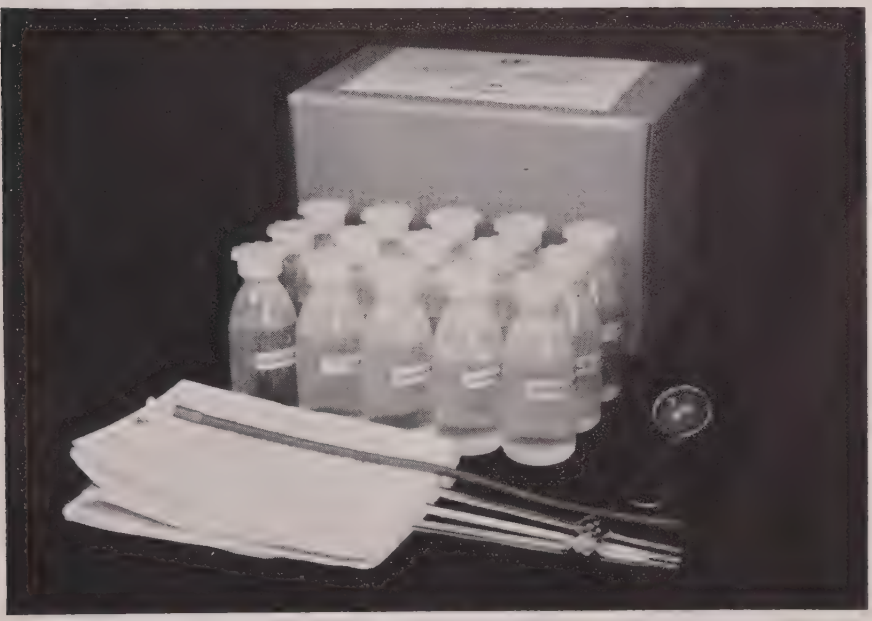

Fig. 1. WHO test kit

insecticides in the area, both in mosquito control and major agricultural uses, should be noted. It should be stressed that this test is not designed to indicate the relative effectiveness of the insecticides in the field where other formulations are used.

Composition of Test Kit

(a) Five different concentrations of each of three insecticides are provided, namely DDT (purified p,p′ isomer), gamma-BHC or lindane (pure gamma isomer) and dieldrin (purified HEOD). They are in the form of 50-ml standard solutions in ethanol, which when added at the rate of 1 ml to 250 ml of water, give concentrations of 0.004, 0.02, 0.10, 0.50 and 2.50 p.p.m.; these concentrations are indicated on each bottle. A standard for 0.0008 p.p.m. dieldrin is also provided for very sensitive species such as certain anophelines.

(b) If it is desired to investigate additional intermediate concentrations, they may be prepared by diluting a portion of a standard solution with pure ethanol (e.g. a concentration of 0.01 p.p.m. may be obtained by diluting the 0.02 p.p.m. standard with an equal quantity of ethanol before taking the 1 ml for addition to the water in the vessel). If higher concentrations are required, they may be obtained from WHO on request.

(c) Three 1-ml pipettes are provided, one for each insecticide. A length of rubber tubing is included to act as a mouthpiece for the pipettes. Two eye-droppers and one metal strainer are also provided for transfer of the larvae. The user is expected to provide his own collecting and test vessels.

Method of Test

(a) For a complete test with one insecticide, sufficient larvae should be collected from the field in order that about 300 individuals of the same species may be selected; they should be in their third or early fourth instar and should be retained in the water in which they were collected until selection for testing. Any larvae showing abnormalities, for example a fuzzy appearance due to the presence of parasites on the body surface, should be discarded. Lots of 20–25 larvae are distributed in each of 12 small beakers each containing 25 ml of water. Their transfer is effected either by means of the strainer provided, or by means of an eye-dropper and a filter-paper cone; during the process they should be rinsed lightly in clean water.

(b) Into each of 12 glass vessels approximately 3–4 inches in diameter (jars, bowls or 500-ml beakers) add 225 ml of water. This water may be distilled, rain, well, stream or tap-water, as free as possible of chlorine or organic contaminants. It should be noted that distilled water obtained commercially may contain traces of poisonous heavy metals. Certain species, such as salt-marsh or tree-hole mosquitoes, may suffer on transfer to relatively pure water and this will be reflected in high control mortalities; in this case water from the breeding site should be used provided it is free of insecticides, care being exercised to exclude detritus. The average temperature of the water should be recorded and should be approximately 25° C; it must not be below 20° nor above 30° C.

(c) The test concentrations are now prepared by pipetting 1 ml of the appropriate standard insecticide solution under the surface of the water in each of the glass vessels and stirring vigorously for 30 seconds with the pipette. In preparing a series of concentrations, the most dilute should be prepared first. There should be two replicates at each concentration, and two control replicates.

(d) Within 15–30 minutes of the preparation of the test concentrations, the mosquito larvae are added to them by tipping the contents of the small beakers into the vessels.

(e) After a period of 24 hours, the numbers of (a) dead, (b) living and (c) moribund larvae are counted and recorded on the form provided. Dead larvae are those that cannot be induced to move when they are probed with a needle in the siphon or the cervical region. Moribund larvae are those incapable of rising to the surface

(within a reasonable period of time) or of showing the characteristic diving reaction when the water is disturbed; they may also show discoloration, unnatural positions, tremors, incoordination or rigor.

(f) As may be seen in the report form, larvae that pupate during the test are eliminated from consideration. Where more than 10 percent of the control larvae pupate in the course of the experiment, the test should be discarded. Tests with control mortality in excess of 20 percent are unsatisfactory and should be repeated.

(g) If the number of larvae available is limited, the test may be performed with only a total of 100 larvae; this involves 2 replicates of 10 larvae each at only 4 concentrations together with 2 controls. The range chosen should include one concentration expected to give complete kill.

General Remarks

(a) The accuracy of the concentrations provided will be affected if the alcohol is allowed to evaporate from the standard solutions. Therefore the bottles should be tightly stoppered after use. The contents should no longer be used when they have decreased below 5 ml. Fresh standard solutions should be obtained from WHO.

(b) Test vessels should be carefully cleaned after use to remove traces of insecticide. They should be thoroughly rinsed, scrubbed with detergent and water or cleaned with potassium dichromate solution, and rinsed again. Pipettes should be thoroughly cleaned with acetone or alcohol.

(c) In calculating the percentage mortalities for each concentration, the moribund and dead larvae in both replicates should be combined. The user may desire to construct the dosage-mortality regression line from the results obtained. For this purpose, logarithmic-probability paper has been provided, on which the results may be plotted. The regression line may be fitted by eye, and the LC_{50} or LC_{90} read from the graph. The regression line may be fitted more exactly by using the method of Litchfield and Wilcoxon (J. Pharm. Exp. Ther. *96*, 99, 1949), reprints of which may be obtained on request from WHO. Alternatively, the LC_{50} may be computed by the statistical method described in WHO/Mal/178 by Swaroop and Uemura.

(d) In cases where the control mortality is above 5 percent, the percentage mortalities should be corrected by Abbott's formula, viz:

$$\frac{\%\text{ Test mortality}-\%\text{ Control mortality}}{100-\%\text{ Control mortality}} \times 100$$

(e) The results recorded on the forms provided should be sent to the World Health Organization (Division of Environmental Sanitation), Palais des Nations, Geneva, Switzerland. Results with anophelines should be addressed to the Division of Malaria Eradication, WHO.

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A STRAIN OF *CULEX TARSALIS* COQ. REPRODUCING WITHOUT BLOOD MEALS [1]

R. E. BELLAMY [2] AND E. H. KARDOS [3]

A blood meal normally is a prerequisite to development and maturation of ova by adult female mosquitoes. The genera *Toxorhynchites* and *Harpagomyia* are exceptions. Since studies by Roubaud (1929), the term "autogeny" has been in general use to describe the capacity of certain mosquitoes to mature and deposit eggs without feeding in the adult stage. Autogeny in forms of the *Culex pipiens* complex has received considerable attention in the Old and New World since Theobald (1901) reported the phenomenon in European specimens and Smith (1904) made observations on specimens in the United States. In reviewing the literature on autogeny in mosquitoes, Trembley (1947, 1955) listed, in addition to the *Culex pipiens* complex, five species of *Aedes,* and one each of *Culiseta* and *Anopheles* that were capable of maturing and depositing a first clutch of eggs without feeding on blood. In the absence of blood, several of these species required at least sugar or fruit juices to produce eggs. Trembley (1947) pointed out that such mosquitoes have been called "autogenous" through a loose application of Roubaud's definition, but are not truly autogenous when any food in the adult stage is required. Whether or not sugar or fruit juices are required, it is of some biological significance that certain species of mosquitoes deposit viable eggs without taking blood.

A colony of *Culex tarsalis* has been maintained at Bakersfield, California since 1952. During the period from 1952 through 1957, wild specimens were added to the colony on three occasions when the stock became greatly diminished. The original and supplementary wild stocks were collected in the vicinity of Bakersfield. Additional material has not been added since 1956. Occasionally during 1957, females which had not taken blood were observed to have partially developed ovaries. Such specimens at times appeared to constitute a large proportion of the unfed colony population, but at other times no ovarian development was noted in unfed specimens.

A group of approximately 100 unfed females in which a high proportion had partially developed ovaries was isolated from the general blood-fed colony in August 1957. These were placed in a separate cage with about 200 colony males. On the assumption that this small group of specimens would provide few or no ova unless permitted to feed on blood, opportunities to take blood from a chicken were provided several times in a two-week period, and some fed. Thereafter, blood-feeding was not permitted in this sub-colony. At the time of this writing (January 1958), the sub-colony has been maintained without blood for over four months, representing approximately six generations. During November and December 1957, an average of more than 50 egg rafts per night was obtained from this sub-colony, but the rafts are always small compared to the usual rafts deposited by females of the blood-fed colony. Counts of the ova of several selected "larger" rafts from the autogenous sub-colony indicate that a raft of more than 125 eggs is exceptional. Large rafts from the blood-fed colony contain 250 to more than 300 ova.

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Pledgets of cotton soaked in a 10 percent solution of commercial corn syrup[4] are provided to adults of both the autogenous and blood-fed colonies, and sliced apples are provided occasionally. However, some individuals of the autogenous sub-colony have matured and deposited egg rafts when no syrup, sugar or fruit was provided. Larvae are fed on the same high protein cattle feed pellet used by Brennan and Harwood (1953) for the Hamilton, Montana colony of *C. tarsalis,* but in an amount about twice what they prescribe (per unit volume of the rearing medium). When larvae are reared on only small amounts of this feed, the tendency for spontaneous development of the ovaries is reduced. This is consistent with observations on *Culex molestus* of the *pipiens* complex (Shute, P. G., in: Mattingly *et al.,* 1951).

In examinations of thousands of wild female *C. tarsalis* collected locally at all seasons of several years, specimens rarely were encountered with the partial degree of ovarian development observed in the laboratory autogenous females. Wild specimens with developed ovaries generally have grossly swollen abdomens, a condition seen in laboratory specimens only after they digest a blood meal. One collection from a shelter four miles northeast of Buttonwillow, Kern County, California, on September 26, 1956, included 35 *C. tarsalis* females with slight abdominal distension and partly gravid appearance. Dissection confirmed that this appearance was the result of developing ova. In retrospect, it seems highly probable that these females were exhibiting autogenous ovarian development. Heretofore, females with partially developed ovaries were interpreted as individuals which had either:

(1) taken only a small amount of blood (as when feeding is interrupted) providing sufficient nutriment for only partial development of the ovaries, or
(2) voided a considerable portion of a full blood meal before digestion of the blood, with a consequent partial development of the ovaries as in the preceding case, or
(3) deposited most of a full complement of ova and retained a few.

All of the above phenomena have been observed with colony specimens and the last, and probably the first, with field materials.

The results from a preliminary rearing experiment supply further evidence of the occurrence of autogeny in the local wild population. Female *C. tarsalis* reared from ova deposited by wild specimens demonstrated a degree of autogeny when the larvae were fed the same rich diet as larvae of the autogenous cage colony. It may be that the food supply in natural breeding areas is normally not sufficiently rich to stimulate autogenous ovarian development.

The possible occurrence of autogeny in wild populations of *C. tarsalis* affects the interpretation of samples of field material when aggregations of specimens are pooled for virus infection tests in encephalitis studies. Gravidity of a wild female has been interpreted as *prima facie* evidence that the specimen had taken at least one blood meal, and Western equine encephalatis virus recovery rates have been higher from pools of gravid specimens than from pools of specimens in which overt evidence of a previous blood meal was lacking (Reeves *et al.,* unpublished). Specimens with only partly developed ovaries and no undigested blood in evidence should perhaps be avoided in preparing pools of specimens "known to have taken blood at least once."

In laboratory experiments, *C. tarsalis* fed heparinized blood on cotton pledgets have deposited small egg rafts. The discovery of autogeny may invalidate previous interpretations that the deposition of small egg rafts was evidence of the extent of blood feeding.

The Rocky Mountain Laboratory (NIH) colony of *C. tarsalis* is reported to require

[4] Karo, Crystal White.

blood meals for oviposition (Hubert *et al.*, 1954). It would be interesting to observe the results from crossing the California autogenous strain with the Montana or other anautogenous strains. At the present time, it is not certain that the autogenous strain is genetically different from other populations of *C. tarsalis*.[5] Duplication of the rich diet provided in the culture of our colony might result in the development of autogenous characteristics by other strains. Experimental comparisons are planned to determine if there are separate strains as in *C. pipiens* or if this is purely a dietary effect.

SUMMARY. In a cage colony of *Culex tarsalis* maintained at Bakersfield, California since 1952, autogenous characteristics were detected in 1957. A sub-colony has been maintained for about six generations in a four-month period with no food provided the adults except corn syrup and apple slices. There are some indications that autogenous development of ova may occur occasionally in wild populations of *C. tarsalis* in Kern County, California.

[5] After preparing this manuscript we received word from Dr. Jowett Chao that he has observed autogeny in a colony of *C. tarsalis* maintained at the Department of Zoology, University of California at Los Angeles. Dr. Chao's observations are reported in an accompanying article.

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AN AUTOGENOUS STRAIN OF *CULEX TARSALIS COQ*[1]

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EAG

Since Roubaud's proposal of the term "autogeny" (1929) in connection with the *Culex pipiens* complex, several cases of autogeny in mosquitoes have been reported. According to Spielman (1957), at least 20 species have been recorded in which autogenous individuals were observed. These are (Spielman, personal correspondence): *Aedes atropalpus* Coquillett, *A. caspius* Pall., *A. scutellaris* Walk., *A. concolor* Taylor, *A. communis* (De Geer), *A detritus* (Haliday), *A. aegypti* (Linn.), *Culex pusillus* (Macq.) Story, *C. molestus* Forsk, *Culiseta longiareolata*

[1] This investigation was aided in part by a Grant E-87 to Dr. G. H. Ball, from the National Institute of Allergy and Infectious Diseases of the National Institute of Health, U. S. Public Health Service, and by a Grant 254 from the Board of Research, University of California.

(Macq.), *C. subochrea* Edw., *C. inornata* (Will.), *Uranotaenia unguiculata* Edw., *Anopheles pictipennis* Phil., *A. claviger* Meig., *A. plumbeus* Steph., *A. atroparvus* (Thiel), *A. crucians* Wiedemann, *Opifex fuscus* Hutton, and *Tripteroides tasmaniensis* (Strickland). Although possibly autogenous strains in other species of mosquitoes have been found, to the best of our knowledge, there is no published record of autogeny in *C. tarsalis*.

When this report was nearly complete, it was learned through correspondence with Dr. R. E. Bellamy that an autogenous strain of *C. tarsalis* had been isolated almost simultaneously in their laboratory at Bakersfield, California (Bellamy and Kardos, 1958). It is not surprising that both discoveries occurred at the same time, since our present colony was initially received (1954) from the one maintained in Dr. Bellamy's laboratory. However, since the methods of rearing in the two laboratories are not entirely the same, and the studies have had slightly different approaches, it is believed that two reports will give a more complete picture of autogeny in *C. tarsalis*.

Our present colony of *C. tarsalis* was established in October 1954 from two dozen egg rafts mailed to us through the courtesy of Dr. Bellamy. No new wild specimens have been added and there has been no sign of diminishing population. After the first 3 generations in a large cage (24″ x 36″ x 72″ high) with controlled light, the adults were able to mate and lay viable eggs after a blood meal in small cages (17″ x 17″ x 36″ high and 12″ x 12″ x 36″ high) without any further light control, an adjustment which has been reported by Hubert, Rush, and Brennan (1954). All the subsequent generations were raised under the latter condition.

The cages were kept in a room at about 80° F. and were supplied with moisture from a cloth wick drawn out from a water bottle. The adults were fed on apple slices, except when canaries were used for blood meals, which was done at irregular intervals for the purpose of obtaining fertile egg rafts. The larvae were fed on fresh yeast with occasional addition of Purina chow. The autogenous strain, now in its fifth generation, has been handled in the same manner, except that it does not require any blood meal for the production of viable eggs.

On September 21, 1955, 10 small egg rafts were found in a cage of adult *C. tarsalis* which had emerged around September 10 and had not had a blood meal. It was estimated that 150 larvae hatched, about 90 of which were reared to adults. The time from egg to the appearance of adults was 16 days. On the assumption that this autogenicity was due to a prolonged September hot spell, the adults were removed to an incubator at 91° F. for a second generation. In 15 days, however, all the adults died without laying any eggs.

The second appearance of autogenous eggs was observed in November 1955, but the resulting adults were too few in number to establish a successful sub-colony. There was no finding of autogeny throughout the year 1956. In November 1957, however, again 2 autogenous egg rafts were found; one on the 10th, and the other on the 13th. Each raft contained about 50 eggs, of which more than half were hatched. Taking this as the first autogenous generation, the subsequent generations were found on December 3 and 26, and on January 15 1958, with exactly 23 days between one generation and the next, except for the most recent complete (4th) generation, in which case the period was shorter by two days.

In all, 13 egg rafts were counted, with an average of 62 eggs per raft, and a range of 40 to 86. Hatching was 76.5 percent, ranging from 60 percent to 100 percent. Not included in the above figures were 4 rafts that failed to hatch; containing 41, 58, 61, and 94 eggs respectively. It is assumed that egg rafts failing to hatch were laid by unmated females, the same

incidence have also been found after a blood meal in the nonautogenous[2] strain.

The times required for the development of corresponding stages in the life cycle were about the same for the autogenous and nonautogenous strains. In both cases, the eggs and pupae took 2 days each, larvae took 11 to 15 days, and the males emerged one to 2 days earlier than the females. In the nonautogenous strain, the females took from 3 to 7 days to deposit eggs after a blood meal; and the period from blood meal to the appearance of the adult males was about 23 days, which was shorter by two days than that of the Rocky Mountain Laboratory colony (Brennan and Harwood, 1953).

However, the autogenous strain females laid fewer egg rafts, each raft contained fewer eggs, and the percentage of hatching was lower. In the nonautogenous strain, each female generally laid one egg raft after a blood meal, without which no eggs were laid at all, and each raft contained an average of 153 eggs, ranging in number from 101 to 191. Hatching averaged 88 percent, with a range of 71 percent to 92.6 percent.

It is evident that the number of eggs per raft in both our autogenous and nonautogenous strains is much lower than that found at Bakersfield by Bellamy and Kardos. This may be due to the differences in the food given to the larvae and the adults, to other differences in laboratory procedure, or to changes in the populations which have developed in the different environments.

An interesting finding in the autogenous strain was that the females laid very large egg rafts after a blood meal. The number of eggs in all the good sized rafts was above 200, the largest being 273, which was more than that of the largest raft of the nonautogenous strain. However, the percentage of hatching of these eggs was very low, ranging from 33 percent to 43 percent, less than half of those laid autogenously.

SUMMARY. A laboratory colony of *Culex tarsalis* Coq., maintained in Los Angeles since 1954, has been found capable of reproducing without a blood meal. As of the present date (February 15, 1958) an autogenous strain has been maintained since November 10, 1957, and is now in the fifth generation. A comparison is made of the biology of the autogenous and of the nonautogenous strains.

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[2] The term "nonautogenous" in this paper refers to the strain originally obtained in October 1954 and maintained since that time in this laboratory on blood meals. Inasmuch as autogeny occurred in September 1955, November 1955, and November 1957, it is possible that the autogenicity has been present for some time, but hidden in the nonautogenous strain.

URBAN DISPERSAL AND ACTIVITY OF *AEDES AEGYPTI*[1]

HARVEY B. MORLAN AND RICHARD O. HAYES

Current interest in *Aedes aegypti* (L.) has been stimulated by recent reports on: the northward progression of sylvan yellow fever in Central America (Trapido and Galindo, 1955; Elton, 1955; Johnson and Farnsworth, 1956), the recent yellow fever outbreak in Trinidad (Gillette, 1956), the campaign for eradication of *A. aegypti* from the Americas (Soper, 1955; Severo, 1956), the history of dengue fever control work in Texas (Chandler, 1956), and DDT-resistance in a strain of *A. aegypti* (Gillette, 1954; Brown and Perry, 1956). Although extensive information on the biology of *A. aegypti* is available, additional quantitative data on dispersion and activity patterns should contribute to the evaluation of the public health hazards involved and of control methods. The present report summarizes observations following ten releases of from 400 to 3000 virgin adult *A. aegypti* females in an urban area of Savannah, Georgia.

Boyce (1911) believed that the flight range of *A. aegypti* might extend 100 meters (328 feet) and cited international quarantine regulations which implied that the species was not capable of flights greater than 200 meters (656 feet). In Nigeria, Dunn (1927) on several occasions found *A. aegypti* breeding 457 meters (1558 feet) from the nearest habitation. The World Health Organization International Sanitary Regulations (Anonymous, 1951) requires that larval and adult control measures be undertaken within the perimeter of airports, "and within a protective area extending for a distance of four hundred meters around that perimeter."

In Brazil, with four separate indoor releases utilizing a total of 3500 *A. aegypti*, Shannon, *et al.* (1930) found dispersion into neighboring houses began within 24 hours and recorded a maximum flight range of 120 meters (394 feet). Over 90 percent of the adults had disappeared from the houses of release by the end of the first week and after two weeks less than one percent could be found anywhere. The longest interval between release and recovery was 17 days.

Shannon and Davis (1930) reported three releases of 4850, 5500, and 12,000 marked *A. aegypti* in small villages of Brazil; percentages of mosquitoes that were captured within 100 meters of the release points were 38, 56, and 23, respectively. Two mosquitoes were recovered in houses more than 300 meters (984 feet) from the point of release. From 12,000 mosquitoes released on an anchored ship, eight were recovered on shore at a distance of about one kilometer (3280 feet). Wiseman, *et al.* (1939) also showed *A. aegypti* to be capable of crossing water, over distances of up to 732 meters (2400 feet), but they believed such flights to be rare.

Four releases of a total of about 266,000 radioactive yellow fever mosquitoes were made in Nigeria by Bugher and Taylor (1949); the maximum dispersal distance observed was 1165 meters (3800 feet). They believed that wind was more instrumental in the distribution of this speices than was its own flight.

Wolfinsohn and Galun (1953), using *A. aegypti* egg collections in jars as an index, found that in each of two tests with a total of 45,000 gravid females, flights of 2.5 kilometers (8200 feet) over uninhabited desert in Israel were made within a period of 24 hours. They noted that in the absence of wind, dispersal was greater and more homogeneous than in the presence of a 1 to 5 mph wind. No eggs were found directly upwind and 80 percent of the eggs were laid "under an

[1] From the Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

angle, the opening of which does not deviate more than 45° from the wind direction."

Teesdale (1955) captured *A. aegypti* over a 6-month period at distances up to 805 meters (2640 feet) from what he believed to be an established release focus in Kenya. He indicated its normal flight to be near the ground, but also recorded having collected adults 15 meters (50 feet) and eggs in containers 22 meters (72 feet) above the ground.

METHODS

Between April and November, 1956, ten studies of *Aedes aegypti* activity and dispersion were completed in a residential area of Savannah, Georgia. Although the species is no longer common in Savannah, a few larvae were found in a single container during 1955. The possibility of released mosquitoes serving as a nucleus for re-establishment of *A. aegypti* in the Savannah area was eliminated by releasing only unfertilized female mosquitoes.

A mechanical separator (Fay, R. W., and H. B. Morlan, in manuscript) was used to separate male and female pupae; the latter being larger were readily retained by the separator. The consistent selection of over 95 percent females was possible using the separator. However, at this level of selection a number of the smaller female pupae were probably discarded. The female pupae were then transferred to 600 ml. beakers (about 100 per beaker), placed within bobbinet-covered gallon cartons, and stored at 75° F. and 75 percent relative humidity. Adult emergence commenced 2 days following pupation. Mosquitoes in any carton found to contain sexually mature males (with completely rotated terminalia) were discarded.

The adults were fed 10 percent sucrose from saturated cotton pads placed upon the bobbinet of the cartons. Females 2 to 10 days of age were used for release. No mortality occurred during transport from the laboratory to the release sites.

The study area selected was the most suitable of several available because of its population density, uniformity of premises and blocks, and its partial isolation from the rest of the city. The area contained no vacant lots, few of the houses were vacant, and the families were of moderate size. In general, the five-room houses, of uniform construction with screened windows and doors, were in good repair. There were few trees or large shrubs, but all yards had grass cover.

In the first five releases, dispersal information was based primarily upon mosquito recoveries obtained in dry-ice baited traps. Rectangular traps, similar to the one described by Bellamy and Reeves (1952), were constructed of ¼" marine plywood with inside dimensions of 15¼" x 11" x 11". Each end of the trap contained a 5½" long screen-wire truncated cone. The diameter of the inner opening of the cone was ¾"; the outer opening was 9". Approximately 1 pound of dry ice was placed within an open pint thermos bottle in each trap. The ice was replenished daily, even though the amount was sufficient for about 48 hours. From 12 to 17 traps were placed in back yards along a line through the center of the block and 11 to 17 were located within houses. The inside traps served primarily as a means of gaining entry into houses for questioning the occupants about mosquito annoyance. Occupants were requested to kill and to save any mosquitoes seen in the houses during the tests.

In the last five releases, greater emphasis was placed on observation of biting activity, only four to six outdoor traps being used in each block. Outdoor collections, beginning about 30 minutes after the mosquitoes were released, were limited to a period beginning 3.5 hours before sunset and ending 1.5 hours after sunset. The major collecting time was 1 hour before or after sunset. Each day, two men moved in opposite directions around the block so that each premises was visited by each man but at different times. Occasionally a third man was employed but collecting

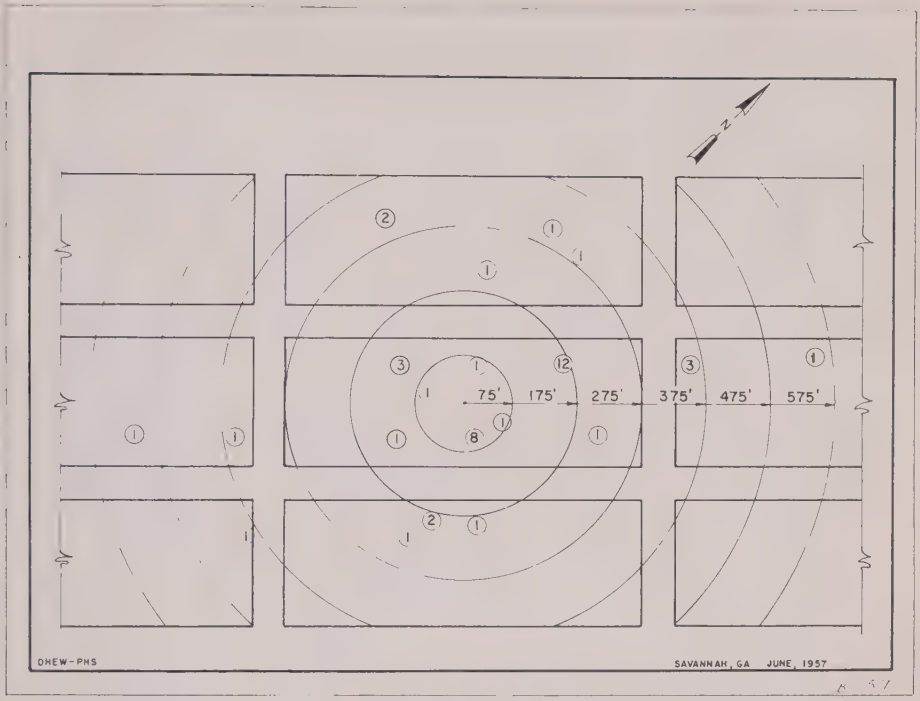

FIG. 1.—Number and location of *Aedes aegypti* recovered in 72 hours after a central release of 1200 females. Rectangles represent city blocks, each with 22 houses.

time was limited to about 5 minutes per man per premises. The major effort was directed toward recovery of mosquitoes from the person of the collector by use of an aspirator. A few supplementary collections were made on the first or second day after release by use of an insect net and a few mosquitoes were aspirated from screens or other outside surfaces of houses. Indoor swatting collections and biting records were based on mosquitoes obtained through the effort of residents. All mosquitoes that were biting, attempting to bite, or engorged at the time of collection were recorded as biting.

Before each release, an assessment was made to determine the abundance and species of mosquitoes naturally present. This assessment also served to familiarize the residents with the test methods and to satisfy their curiosity regarding the traps.

The ten releases are given numbers for cross reference of tabular data. Tests 1 through 5 and 8 were releases from a single point to obtain information on dispersal. Tests 6, 7, 9, and 10 were multiple releases from 3 to 5 points equally spaced in a single block to determine extent of biting activity as related to houses and residents. The total number of females released per test was 3090 (No. 1), 1200 (Nos. 8 and 10), 900 (No. 9), 825 (No. 2), 800 (No. 7), and 400 (Nos. 3 to 6).

RESULTS

Dispersal. In five tests of dispersal within a city block (table 1), an average of 78 percent (range 53 to 88) of the mosquitoes recovered were collected within 75 feet of the release point, 18 percent (10 to 40) were taken 76 to 175 feet away, and only 4 percent (0 to 10) were re-

covered 176 to 275 feet from the point of release. Collections were limited to an area within 275 feet from the release point. In three releases each with 400 females, 79 to 88 percent of the recovered mosquitoes were collected within 75 feet of the release point; with 825 and 3090 females released, 71 percent and 53 percent, respectively, were collected in the same distance. While dispersion appeared from visual observation to be rapid, combined data for five tests indicated a less even distribution during the first 24 hours (when the percentages recovered were 93, 6, and 1 at 1 to 75 feet, 76 to 175 feet, and 176 to 275 feet, respectively) than during the second 24 hours when corresponding percentages recovered were 30, 57, and 13.

Release of 1200 females in the center of a nine-block study area (test number 8) resulted in dispersal for distances up to 575 feet. The actual maximum distance of dispersal may have been in excess of the observed distance since the latter was at the outer edge of the area of intensive survey. Within 2 hours after release, mosquitoes were collected in three adjacent blocks and the greatest observed dispersal was about 375 feet. Of the 44 females recovered in 72 hours, 28 were collected in the release block and 5, 4, 4, 2, and 1 were collected in 5 of the 8 surrounding blocks (figure 1). Twenty-five percent of the mosquitoes recovered were collected within 75 feet of the release point, 36 percent were taken at distances of 76 to 175 feet, 14 percent at 176 to 275 feet, 18 percent at 276 to 375 feet, 2 percent at 376 to 475 feet, and 5 percent at 476 to 575 feet (table 2).

TABLE 1.—Urban dispersal of *Aedes aegypti*: the number of females released was 3090 in test number 1, 825 in 2, and 400 each in 3, 4, and 5. Assessment was limited to one block (an area within 275 feet from the central release point)

Test No.	Recovery Period (Hours after Release)	Females Recovered					
		Number			Percent		
		Dispersal Distance (ft.)			Dispersal Distance (ft.)		
		1–75	76–175	176–275	1–75	76–175	176–275
1	0–24	6	0	0	100	0	0
	24–48	2	6	1	22	67	11
	Total	8	6	1	53	40	7
2	0–24	10	1	0	91	9	0
	24–48	4	2	2	50	25	25
	48–72	1	1	0	50	50	0
	Total	15	4	2	71	19	10
3	0–24	21	0	0	100	0	0
	24–48	0	3	0	0	100	0
	48–72	0	0	0	0	0	0
	Total	21	3	0	88	12	0
4	0–24	26	2	1	90	7	3
	24–48	1	1	0	50	50	0
	Total	27	3	1	87	10	3
5	0–24	11	2	0	85	15	0
	24–48	0	1	0	0	100	0
	48–72	0	0	0	0	0	0
	Total	11	3	0	79	21	0
1–5	0–24	74	5	1	93	6	1
	24–48	7	13	3	30	57	13
	48–72	1	1	0	50	50	0
	Total	82	19	4	78	18	4

TABLE 2.—Urban dispersal of *Aedes aegypti* based on a release of 1200 females (test number 8)

Dispersal Distance (Feet)	Females Recovered: Number, Hours After Release 0–24	24–48	48–72	Total	Percent, Hours After Release 0–24	24–48	48–72	Average
1–75	9	0	2	11	33	0	18	25
76–175	9	4	3	16	33	67	27	36
176–275	3	1	2	6	11	17	18	14
276–375	4	1	3	8	15	17	27	18
376–475	1	0	0	1	4	0	0	2
476–575	1	0	1	2	4	0	9	5

Activity. Activity and source of recovery of the mosquitoes by 24-hour periods after release for tests 6 through 10 are shown in table 3. While collection methods had a major influence on recovery records, the accumulated data served to establish the general success of mosquitoes in entering houses and obtaining blood meals.

In tests 6 through 10, 208 (60 percent) of the mosquitoes recovered were collected outdoors. Of these recoveries, 157 (75 percent) were biting records. Approximately 94 percent of the mosquitoes collected indoors were biting.

Comparative observations of *A. aegypti* activity as related to houses and residents of a single city block are shown in table 4. Negative collection records from many households could indicate lack of effort or skill rather than absence of mosquitoes.

An attack rate, calculated by dividing the number of biting and landing records x 100 by the number of residents in the cooperating households, gives some basis for comparison of activity in different releases. In the two releases of 1200 mosquitoes, attack rates were 32 (test 8) and 187 (test 10). The lower rate may be attributed to use of a single release point and slightly less outdoor collection time in the block of release. The lowest attack rate (28), observed in test number 7, may have resulted from adverse weather conditions. In tests 6, 9, and 10, attack rates were 57, 90, and 187 with multiple-point

TABLE 3.—Female *Aedes aegypti* recovery records to show activity and source of collections by recovery periods, tests 6 through 10

Test No.	Recovery Period (Hours After Release)	Number of Females Recovered: Outdoors, Biting	Outdoors, Not Biting	Outdoors, Total	Indoors, Biting	Indoors, Not Biting	Indoors, Total	Outdoors and Indoors, Biting	Outdoors and Indoors, Not Biting	Outdoors and Indoors, Total
6	0–72	13	8	21	24	0	24	37	8	45
7	0–48	7	7	14	14	2	16	21	9	30
8	0–72	8	7	15	26	3	29	34	10	44
9	0–72	22	7	29	48	1	49	70	8	78
10	0–72	107	22	129	18	2	20	125	24	149
6–10	Total	157	51	208	130	8	138	287	59	346

TABLE 4.—Comparative observations of *Aedes aegypti* activity in one city block

Test Number	6	7	8	9	10	6 to 10
No. of females released	400	800	1200	900	1200	4500
No. of release points	5	5	1	3	5	19
Total No. of females recovered	45	30	28*	78	149	330
Total percent recovered	11	4	2	9	12	7
No. of females recovered indoors	24	16	19	49	20	128
No. of biting or landing records	37	21	22	70	125	275
No. of cooperating households in block	16	20	17	19	18	90
Percent of cooperating households entered by *A. aegypti*	62	30	29	58	56	46
No. of residents in cooperating households	65	74	68	78	67	352
Attack rate †	57	28	32	90	187	78

* Plus 16 additional mosquitoes recovered in five adjacent blocks.
† Quotients obtained from dividing No. of biting or landing records x 100 by No. of residents.

releases of 400, 900, and 1200 mosquitoes, respectively. In each of these tests, mosquitoes entered well over 50 percent of the cooperating households.

With continuous observations divided into 6 one-half-hour intervals beginning 90 minutes before and ending 90 minutes after sunset, the average biting rates per man-hour (combined data from 5 tests) were 1.6, 5.8, 2.2, 1.3, and 1.2, respectively. In the same period, the average biting rate per man hour for a 15-minute interval varied from 0.5 to 17.5 on the day of release and from 0.2 to 7.5 for the entire assessment period (table 5). On the day of release and on the second day after release, the highest biting rates per man hour (17.5 and 3.3) were in a 15-minute period begining 45 minutes before sunset. On the first day after release, the highest

TABLE 5.—Time of *Aedes aegypti* activity: outdoor biting records combined from urban release tests 6 through 10

Time in 15-Minute Periods Beginning at Sunset	Man-Hours of Collection					Biting* Rates per Man Hrs. of Collection				
	Release Day Plus					Release Day Plus				
	0	1	2	3	0–3	0	1	2	3	0–3
−90	0.1	–	–	0.9	1.0	10.0	–	–	0	1.0
−75	0.7	0.5	0.2	0.1	1.5	4.3	0	0	0	2.0
−60	2.0	1.6	1.4	–	5.0	8.5	0.6	0	–	3.6
−45	2.0	2.0	2.1	–	6.1	17.5	2.0	3.3	–	7.5
−30	2.3	2.3	2.5	–	7.1	7.0	2.2	0	–	3.0
−15	3.0	2.5	2.5	–	8.0	3.3	0.4	0.4	–	1.5
0	3.1	2.5	2.5	–	8.1	7.4	1.6	0.4	–	3.5
+15	3.5	2.5	2.4	–	8.4	2.3	0	0	–	1.0
+30	3.0	2.3	1.9	–	7.2	3.7	1.3	0	–	1.9
+45	2.2	1.1	0.9	–	4.2	0.5	0	0	–	0.2
+60	1.4	0.1	–	–	1.5	0.7	0	–	–	0.7
+75	0.2	–	–	–	0.2	5.0	–	–	–	5.0

* Mosquitoes biting, attempting to bite, or engorged.

rate (2.2) was in the period beginning 30 minutes before sunset. In these limited observations, the maximum biting rates occurred during the hour before sunset.

Longevity of released mosquitoes is unknown. A point of rapidly diminishing returns, in number recovered per man-hour of collection time, occurred within a short time after release (table 5). In the three tests with 48-hour assessment, 76 percent of 76 females were recovered within 24 hours of release. In the seven tests with 72-hour assessment, 85 percent of 375 females were recovered in the first 24 hours after release, 10 percent were recovered 24 to 48 hours after release, and 5 percent were recovered 48 to 72 hours after release. While the rapid decline in recovery rates presumably reflects some decimation of the released population, it also indicates increased difficulty of recovery due to continued dispersal and reduced activity after obtaining the initial blood meal.

In the ten tests, 4.7 percent of the 9615 females released were recovered. More effective collection methods contributed to a 7.7 percent recovery for tests 6 to 10, compared to a 2.1 percent recovery in tests 1 to 5. Recovery percentages, listed below in decreasing order with number of females released in parentheses, are followed by corresponding test numbers, minimum temperatures, and mean wind velocities on release days:

Percent	Number	° F.	mph
12.4 (1200)	10	60	6.6
11.2 (400)	6	69	7.7
8.7 (900)	9	57	9.0
7.7 (400)	4	65	14.5
5.7 (400)	3	68	15.2
3.8 (800)	7	54	18.2
3.5 (400)	5	75	8.0
2.5 (825)	2	55	8.4
2.3 (1200)	8	55	5.9
0.5 (3090)	1	47	19.3

The maximum temperature on the day of release for test number 5 was 96° F.; it did not exceed 87° F. in any of the other tests. With one exception, the highest percent recoveries were from multiple-point releases (test numbers 10, 6, 9, and 7). In both single-point releases (test numbers 4, 3, 5, 2, 8, and 1) and multiple-point releases, the lowest percent recovery was associated with a combination of low temperature and high wind.

Summary

In an urban area of Savannah, Georgia, 4.7 percent of 9615 *Aedes aegypti* females released in 10 tests were recovered.

In five dispersal tests in which collection was limited to one block (within a radius of 275 feet), 78 percent of the recovered mosquitoes were within 75 feet of the release point and 18 percent and 4 percent were recovered at distances of 76 to 175 feet and 176 to 275 feet, respectively.

In a release of 1200 females in which collection was extended to an area within a radius of 575 feet, 25 percent of the recovered mosquitoes were collected within 75 feet of the release point, 36 percent at a distance of 76 to 175 feet, 14 percent at 176 to 275 feet, 18 percent at 276 to 375 feet, 2 percent at 376 to 475 feet, and 5 percent at 476 to 575 feet.

In multiple-point releases of 400, 900, and 1200 females in a single block, attack rates (number of biting records x 100 divided by the number of residents in cooperating households) were 57, 90, and 187, respectively. In the same tests, mosquitoes entered 62, 58, and 56 percent of the cooperating households, respectively.

Limited observations showed maximum outdoor biting rates occurred during the hour before sunset.

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NOTICE CONCERNING ATTACHMENTS TO MINUTES OF MEETING

In the Minutes of the Annual Meeting, which follow in the next section, reports of committees, referred to in the account of the meeting, are given at the end as numbered "attachments." Because many of them included tables or statistics which could not be separated or broken up, the Attachments have been placed where they would fit most conveniently without wasting space, rather than in numerical order. An index to the pages where the Attachments appear is given on page 171.

ASSOCIATION NEWS

MINUTES OF THE 14TH ANNUAL MEETING OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION, WASHINGTON, D. C., FEBRUARY 23–26, 1958

Recorded and Reported by A. F. Geib

A meeting of the Board of Directors of the A.M.C.A. was convened at the Willard Hotel, Washington, D. C., 10 a.m., February 23, 1958 by Association President A. W. Lindquist.

Present were: A. W. Lindquist, President; John W. Hirst, President-elect; A. D. Hess, Vice-President; T. G. Raley, Executive Secretary; L. W. Smith, Treasurer; A. F. Geib, Recording Secretary; Fred Stutz, Past President (1957); R. F. Peters, Past President (1956); Bob Vannote, National Advisor; Regional Directors—D. M. Jobbins, N. Atlantic; W. E. Bickley, S.E. Central; Sam Minnich, S. Atlantic; D. W. Micks, S.W. Central; C. F. Scheel, N.E. Central; C. D. Grant, S. Pacific; C. M. Gjullin, N. Pacific; T. A. Schoenfeld, N.W. Central; B. Hocking, Canada.

Absent was: Regional Director H. P. S. Gillette, Mexico and S. America.

Committeemen and others attending from time to time were: Don Collins, Rowland Dorer, Ernestine Thurman, F. C. Bishopp, R. A. Hoffman, W. C. McDuffie, J. E. Graham, R. L. Armstrong, Don Johnson, John Porter, Mrs. Margaret G. Slater, Ed Davis, Chris Williamson, Bailey Pepper, John Mulrennan and Chester Robinson.

It was moved by Bickley that the minutes of the 13th Annual Meeting of the A.M.C.A. be approved as published in the June 1957 issue of *Mosquito News,* seconded by Grant; carried.

President Lindquist appointed the following to the Resolutions Committee: Chairman, R. F. Peters; Members, Col. R. W. Bunn, P. B. Brockway, Jr., and R. L. Vannote.

President Lindquist reported to the membership (Attachment #1).

The President called for the report of the Nominating Committee. Submitted by Chairman Stutz (Attachment #2).

Treasurer Lester Smith presented a report on the financial affairs of the Association and audit of accounts (Attachment #3).

Report of the Editor of *Mosquito News,* presented by Don Collins (Attachment #4).

Discussion was held concerning *Mosquito News,* the official publication of the Association. It was moved by R. F. Peters that the Association acknowledge appreciation for the excellent manner in which Don Collins, Mrs. Slater and the Editorial Staff are handling and preparing *Mosquito News;* motion was seconded by Hess; carried.

Report from the Committee on Publication of *Mosquito News* was presented by Hirst for Twinn (Attachment #5).

Peters recommended that authors of invitational papers be extended the courtesy and option of having their papers published.

Report from the Committee on Finance was presented by Scheel (Attachment #6).

Following presentation, Raley suggested that additional funds, a greater amount than provided last year, be made available for the publication and mailing of *Mosquito News.*

Hess moved that $8500.00 be budgeted for the publication and mailing of *Mosquito News* for 1958 (Vol. 18); seconded by Peters; motion carried.

Hirst suggested that a committee be appointed to review itemizing the budget with reference to the primary cost of printing and handling reprints. The President

appointed Hess, Jobbins and Micks to work with the Treasurer and the Finance Committee on this revision.

Raley recommended that budgeted travel expenses be equally divided among the authorized officers of the Association eligible for travel expense: Executive Secretary, Editor of *Mosquito News,* Treasurer and Advertising Manager.

Peters suggested the formation of a Ways and Means Committee, composed of Past Presidents of the Association, to review the long range objectives of the Association, methods of financing and policy matters. No action taken.

Peters moved acceptance of the Finance Committee report; seconded by Hirst; carried.

The National Advisor, R. L. Vannote, reported on his investigation into the potentialities of grants-in-aid to provide funds for specific Association activities (Attachment #7).

Report from the Program Committee by Chairman Hirst: It required 1600 letters to develop and finalize the program which started slowly snowballing at the end. Wished to thank all those who aided, and particularly Bickley and Dorer who carried most of the work and responsibility. Grant moved acceptance of the report; seconded by Micks; carried.

Meeting recessed at 12:30 p.m. Meeting reconvened at 1:45 p.m.

Report from the Local Arrangements Committee, Bickley, Chairman: It appeared that revenues would amply cover costs for this annual conference. It was stated that a balance of approximately $1500.00 was expected and could be credited to the Association toward the publication of *Mosquito News,* following completion of the conference. Bickley and the Committee were thanked and commended for a job well done.

Report of the Committee on Sale of Advertising Space. Reported by Scheel for Creadon (Attachment #8). Bickley moved acceptance with thanks; seconded by Hess; carried.

Report from the Good Neighbor Committee, Ernestine B. Thurman, Chairman (Attachment #9).

Hess moved acceptance of report and to establish a budget and authorize expenditures up to $50.00 of Good Neighbor Funds in carrying out functions of this committee; seconded by Peters; carried.

Report from Committee on Miscellaneous Publications, Hirst, Chairman.

Hirst reviewed the editing problems of Bulletin #4, and recommended that Bulletin #4 no longer be considered for publication; seconded by Minnich. Following discussion, motion and second were withdrawn. Hess moved that further consideration of Bulletin #4 be postponed at this time, but that the existing manuscript be deposited in the Secretary's office, where review could be made in the future if desired; seconded by Micks; carried. Bickley commented that Bulletin #4 was important to Maryland and Lindquist remarked that it was important throughout the country.

Report from Committee on Sale of Miscellaneous Publications, Graham, Chairman (Attachment #10). Minnich moved acceptance of report as read; seconded by Scheel; carried.

Report from Membership Committee, Don Johnson, Chairman (Attachment #11).

Reported a net gain of 86 members during 1957, compared to 45 for 1956. Raley moved acceptance of report; seconded by Smith; carried.

Report from Public Relations Committee, Dorer, Chairman (Attachment #12).

Submitted written report containing several recommendations. Recommendations 1 and 2, related to pins, and no action was taken. Hirst presented plaques and pins to Past Presidents of Association. He also exhibited Association pins which he had made at his own expense and recommended their adoption and sale at this meeting. Hess moved acceptance of the Hirst pins as official insignia of the Association and to put them on sale at this meeting at $1.50 apiece; seconded by Hocking; carried. (This action obviated

the necessity for action on the committee's recommendation.)

Recommendation #3. Increase of dues by $1.00. It was moved by Hess to postpone action on this matter; seconded by Peters; carried.

Recommendation #4. Hess moved we adopt recommendation to prepare exhibit and the President appoint a committee to develop and have exhibit made with an authorized expenditure up to $200.00; seconded by Hirst; carried.

Recommendation #5. Hess moved to defer action on this matter for one year; seconded by Peters; carried.

Recommendation #6. Bickley moved to refer this to the incoming bylaws committee; seconded by Hess; carried.

Recommendation #7. Bickley moved to refer this to the Publications Committee without recommendations; seconded by Hess, carried.

It was moved by Smith to accept report; seconded by Gjullin; carried.

Reopening report from Finance Committee for consideration of proposed budget (Attachment #13).

Committee review and recommendations reported by Hess.

1. That $8,500.00 be allocated for the publication and mailing of *Mosquito News* for 1958.

2. The cost of reprints were self-sustaining, therefore, that this item not be included in the budget.

3. That the existing schedule on cost of reprints be increased by approximately 5 percent.

4. That the amount available for travel expense of Association officers be set at $500.00, and its distribution be left flexible as to use.

5. That the amount of $200.00 be budgeted for preparation of an exhibit. Hess moved that the revised budget be approved containing these recommendations; seconded by Scheel; carried.

Report from Committee on Research and Development, McDuffie, Chairman (Attachment #14). Minnich moved acceptance of report; seconded by Grant; carried.

Report from Historical Committee not presented. It is understood (Peters) that the Historical report is practically ready for publication.

Report from the Committee on Bylaws, Bailey Pepper, Chairman.

Only item for consideration is the method for election of officers of the Association. Recommended postponing action on this matter until committee can meet and review. Following committee review, recommendations will be submitted for consideration of this or the new Board. No action.

Report of the Committee on Legislation, Mulrennan, Chairman.

No legislative action for consideration. Minnick moved acceptance; seconded by Vannote; carried.

Other Business.

1. Report from the Committee on the Publication of an issue of *Mosquito News* in commemoration of W. H. W. Komp; Jobbins, Chairman. Review has not been completed—recommends the committee be continued. Smith moved acceptance; seconded by Minnich; carried.

2. A letter from Gray and Mulhern, recommending that not more than two citations per year be granted Association members in recognition of outstanding and meritorious service. Stutz commented that no action had been taken on previous consideration of this matter. Moved by Smith that letter be filed; seconded by Stutz; carried.

Report from Business Manager of Miscellaneous Publications, C. Williamson, Chairman (Attachment #15).

Bulletin #1—Supply is exhausted. Recommend that it be rewritten and brought up-to-date. If undertaken, could publication funds be obtained through Ford Foundation?

Bulletin #2—In good supply, with 900 copies available.

Bulletin #3—Over half sold, demand slow and in good supply, with 600 copies available.

Recommends further advertising to aid

sales, particularly in *Mosquito News,* calling attention to the availability of the publications. Hess moved acceptance of the report; seconded by Peters; carried.

Report from National Advisor, Vannote.

Proposed that the Association sponsor educational and field meetings in various regions of the country, collaborating with the U. S. Fish and Wildlife Service on problems relating to waterfowl management and mosquito control. Requested sanction of a Wildlife Seminar this spring or fall and the scheduling of annual meetings with Fish and Wildlife thereafter.

Noted that a resolution had been passed at the Salt Lake meeting, authorizing distribution of pins to Past Presidents. These citations had been made and sent to those eligible. Minnich moved acceptance of report; seconded by Hirst; carried.

Report from the Executive Secretary.

1—The Secretary has received a letter signed by ten members of the Association, requesting that Dr. Stearns be made an honorary member of the A.M.C.A. Raley so moved, seconded by Hess; carried.

2—In receipt of a request from the Smithsonian Institute to be put on the mailing list and receive free, all copies of *Mosquito News* from the 14th volume on. Raley so moved, seconded by Hirst; carried.

3—It was moved by Minnich, that where the citations of Past Presidents had been lost or destroyed, they could request duplicates at cost. Said duplicates would be signed by the President signing their original, or in the case where the original signee was no longer a member of the Association, the duplicate citation would be signed by the President holding office at the time; seconded by Schoenfeld; carried.

4—The issuing of copies of *Mosquito News* to agencies, libraries, institutions, etc. was left to the Secretary's discretion.

5—Raley noted that several back issues of *Mosquito News* were no longer available. He requested that anyone having copies of any issues that they no longer need, please turn them in to the Secretary.

6—Raley requested exploration of the possibility of getting extra copies of the proceedings of the Virginia Beach Meetings. Dorer was instructed to follow up.

7—Hirst moved that the Secretary affiliate the Association with various state and regional associations to obtain copies of their proceedings, seconded by Peters; carried.

8—The Secretary suggested that the Association prepare a manual of guidance for meetings and affairs of the Association. No action.

9—The Secretary reported that invitations for coming annual meetings have been received from Hawaii, Louisiana, Nebraska, Illinois, Utah and Texas. Schoenfeld presented a formal invitation for the Association to hold its 1959 Annual Meeting with the Utah Association in Salt Lake City, Utah.

New Business.

Bickley called attention to considerable inflammatory publicity the past few months relative to the use of insecticides and their harmful effect on fish and wildlife. He requested that the Association counter this publicity by releasing information and letters to agencies, universities and groups concerned with this problem. Hirst moved that the request be referred to the Resolutions Committee, seconded by Smith; carried.

Meeting adjourned at 5:30 p.m.

The report of the Nominating Committee was made to the membership during the first general session of the meeting, Monday a.m., February 24, 1958. Chairman Stutz (Attachment #2).

AMCA BUSINESS MEETING—4:45 P.M., WEDNESDAY, FEBRUARY 26, 1958

President Lindquist opened the general business meeting by calling for consideration of the minutes of the Association for 1957 as presented in the June 1957 issue of *Mosquito News.* Chris Williamson moved acceptance of the minutes, seconded by Washburn; carried.

The Association Treasurer's Report was received from Lester Smith (Attachment #3). Don Collins, Editor *Mosquito News* added to the report that income and expenses from the publication and mailing of *Mosquito News* were in balance. He pointed out that recent issues tended to emphasize articles of a technical nature; that he would like to receive more articles on operational activities. The Editor will be glad to aid authors in the preparation and editing of papers, if desired.

Bickley reported for the Local Arrangements Committee. Registration at these meetings was approximately 350, with 276 attending the banquet. Gross income from exhibits amounted to approximately $1,600.00 and from registration approximately $1,500.00. He estimated there would be a net revenue of approximately $1,500.00 which would be credited to the Association in support of the publication of *Mosquito News.*

Creadon reported for the Advertising Committee. Reviewed report submitted at the Board Meeting (Attachment #8). Requested help in soliciting advertising for *Mosquito News.*

Hirst reported for Twinn on the activities of the Committee on Publication of *Mosquito News.* Reviewed report as submitted at Board sessions (Attachment #5).

Ernestine Thurman reported on activities of the Good Neighbor Club Committee. Reviewed report submitted at Board meeting (Attachment #9).

Hirst reported on activities of Miscellaneous Publications Committee. Reviewed report as submitted at Board Meeting. See discussion in earlier Board meeting.

Graham reported on activities of Committee on the Sale of Miscellaneous Publications. Reviewed report as submitted earlier at Board Meeting (Attachment #10).

No report from Committee on Membership. Submitted earlier to Board, (Attachment #11).

No report from Finance Committee. Submitted earlier at Board Meeting. (Attachment #13).

Report on Public Relations Committee by Dorer. Reviewed report as previously submitted to Board (Attachment #12).

No report from History Committee.

Report from the Bylaws Committee by Chairman Pepper (Attachment #16).

Pepper moved that the Board consider the committee recommendations, seconded by Hess; carried.

Report from Legislative Committee, Chairman Mulrennan. No requests for legislative considerations this past year; nothing undertaken by Committee.

Report from National Advisor Vannote. Reviewed report as submitted at earlier Board Meeting (Attachment #7). Suggested that Board consider recommendations in the report.

Report from Executive Secretary, T. G. Raley.

1. Financial condition of the Association is good; during 1957 fund balance increased approximately $800.00.

2. The Historical Committee Report has been completed. It remains to be determined when and how it will be published, perhaps with the aid of the Ford Foundation.

3. Requested that any extra copies of *Mosquito News* be sent to the office of the Executive Secretary or reported to that office. Some issues are exhausted or in short supply, which occasionally results in loss of sale of complete volumes.

4. Occasional Board action during the year by mail: Appointment of Schoenfeld to replace Rees on Board; approval of Seminar with Fish and Wildlife Service and other interested agencies.

5. Presidential actions required during the year were appointment of Dorer as Chairman of Public Relations Committee to replace Buchanan—resigned.

6. Noted that Budget allowances for officers for 1958 were approved by the Board as follows: Executive Secretary, $200.00; Treasurer, $100.00; Advertising Manager, $100.00; Editor, *Mosquito News,* $100.00.

Executive Secretary Raley moved acceptance of his report, seconded by Washburn; carried.

Hirst reviewed Membership report (Attachment #11). Also called attention to and commended Advertising Committee, Creadon, Chairman, on the excellent returns from advertising in *Mosquito News,* which represented a considerable increase from 1956 to 1957.

Raley called attention to increased interest in and growth of mosquito control activity throughout the nation. Noted that control activity was getting underway in Minnesota; a new State Association had just been formed in Louisiana and considerable interest was developing in the State of Washington.

Don Pletsch raised the question as to why additional financial aid might be needed through the Ford Foundation in view of the good financial condition of the Association. Both Raley and Vannote called attention to the fact that since the officers carried on the affairs of the Association on their own time and at their own expense; when financially able, the Association should bear at least a part of these expenses. Also, that the size and scope of *Mosquito News* could be enlarged and additional projects developed within the Association.

Report of the Resolutions Committee, Chairman Peters (Attachment #18).

Resolution #1. This resolution included seven separate but related sections, voted upon as a unit (See Resolutions in Attachments).

Peters moved adoption of the Resolution, seconded by Grant; carried.

Resolution #2 (See Attachments).

Peters moved adoption of this Resolution, seconded by Washburn; carried.

The Executive Secretary reported that a number of invitations had been received for the next two or three Annual Meetings. Additional invitations for the next Annual Meeting were invited. All will be referred to the Board of Directors for consideration and action.

Report from the Nominating Committee, Chairman Stutz (Attachment #2).

Mulrennan moved that the nominations be closed and that the Secretary be instructed to cast a unanimous vote in favor of the slate of officers submitted by the Nominating Committee, seconded by Rogers; carried.

The newly elected Officers of the Association were escorted to the speakers' table: President Hirst by Past President Lindquist; President-Elect Hess by Past President Peters, and Vice-president Jobbins by Past President Dorer.

The new President, Hirst, stated he was honored to accept the office and would strive to fulfill his new duties to the best of his ability. He called for the aid and services of all, and pointed out that three members had already offered to help. He declared the meeting adjourned at 6 p.m.

MINUTES OF THE BUSINESS MEETING OF THE BOARD OF DIRECTORS, AMERICAN MOSQUITO CONTROL ASSOCIATION, 6:05 P.M., FEBRUARY 26, 1958. WASHINGTON, D. C.

Present: John Hirst, A. W. Lindquist, Fred Stutz, Richard Peters, Rowland Dorer, Ted Raley, Archie Hess, Manley Jobbins, Arthur Geib, Don Collins, Bruce Brockway, Francis Creadon, John Mulrennan, Bob Vannote, Lester Smith, W. E. Bickley, Don Grant, Ed Washburn, B. Hocking, Don Micks, Jay Graham, and T. A. Schoenfeld.

The meeting was called to order by President Hirst.

The first matter of business concerned the appointment of a successor for Manley Jobbins to the Board of Directors representing the North Atlantic Region. Bickley moved that Vernon Conant be appointed to the Board of Directors representing the North Atlantic Region to fill the unexpired term of Manley Jobbins, newly elected Vice-president, seconded by Stutz; carried.

The Nominating Committee for 1958 was submitted by Lindquist for review

and consideration. Stutz moved acceptance of the Committee as submitted, seconded by Raley; carried, (Attachment #17).

Grant moved that the Association purchase, and reimburse Hirst for, all the label pins presented at these meetings by Hirst and adopted as official insignia for the Association. Seconded by Hess; carried.

Hess moved that the Board of Directors approve the recommendations of the Bylaws Committee and poll the membership by mail concerning these recommendations. (Attachment #16) That the Bylaws Committee be instructed to prepare the information and send to the membership for vote, seconded by Micks; carried.

Bickley moved that Vannote be reappointed National Advisor, seconded by Hess; carried.

The President was instructed to name the membership of the various committees of the Association and send his recommendations to the Board for consideration and approval by mail.

Raley moved that the papers presented at this, the 14th Annual Meeting of the American Mosquito Control Association be published in *Mosquito News* in accord with established policies and practices, seconded by Jobbins; carried.

Smith moved that Mr. Thom be made assistant to the Treasurer for 1958, seconded by Jobbins; carried.

Mr. Schoenfeld invited the Association to hold its next Annual Meeting in Salt Lake City, Utah. Hess moved that we accept the invitation and hold the next Annual Meeting of the A.M.C.A. in Salt Lake City in the spring of 1959, with the actual dates to be determined later, seconded by Graham; carried.

Raley moved that the President be instructed to write a letter of commendation to Dr. James E. Allen, Commissioner of Education, New York State Education Building, Albany, New York, for the outstanding work being done by Don Collins and Mrs. Slater in the editing and publishing of *Mosquito News,* seconded by Bickley; carried.

Meeting adjourned at 6:50 p.m.

ATTACHMENT #1

President's Report for 1957
by A. W. Lindquist

In this annual report I shall summarize some of the progress during the last year and give my impressions as to the strength and efficiency of our organization.

By and large the AMCA has had a good year. Progress has been steady—perhaps not as rapid as one would desire, but the Association has certainly been moving forward. There have been no spectacular or new problems and no reverses that have come to my attention.

Growth of prestige of the Association and interest in mosquito control by the membership and the public have continued unabated. The increase in new members has been good and we welcome them and hope they benefit by being with us. Advertising in *Mosquito News* has expanded greatly, and we are happy for this since our finances are thereby bolstered.

I have been amazed at the huge amount of correspondence necessary to carry out the business of the Association. There seems to be excellent communication between the offices of the President, the President-elect, the Executive Secretary, and the National Advisor, as well as others. In common with other presidents I have written numerous letters to the various Directors.

Mosquito News has an ever-widening circle of friends and admirers. The usefulness and acceptance of this periodical is increasing much more than we can know and measure. Because of its quality and appeal to mosquito workers, it enjoys a world-wide circulation and is found in over 120 libraries to be read by hundreds of students, researchers, and leaders of various scientific disciplines. It is gratifying to meditate on the impact this periodical and our Association have on mosquito work throughout the world.

Research on mosquito control has progressed steadily, but there have been no dramatic and far-reaching new developments. The methods and materials have been improved but, on the whole, we are approaching mosquito control in the same manner as in other years. Even though major break-throughs have not occurred, I believe that the improvement of existing techniques is highly important and can be classed as progress. Resistance of mosquitoes as well as other insects to insecticides is an increasing problem. Fortunately, research has kept pace in developing substitute materials. The new insecticides may not be as effective as the old ones but they are a big help in control. Research on the basic cause and nature of resistance and the seeking of counter measures is continuing on a world-wide basis. It is hoped that these efforts will bear fruit in alleviating the resistance problem.

Research here and there suggests some new ideas and concepts regarding control of mosquitoes. There seems to be some progress regarding the possible use of mitotic poisons and insect hormones for insect control. Investigators are exploring other new ideas and it is my feeling that these may bear fruit for future control use.

Certain important trends appeared during the year which will likely have a great impact on the future of all sciences, including biology and entomology. For the first time in several decades a national awareness of the need for basic research has arisen. Leaders in government, the press, and scientific groups have become concerned about the urgent need for additional basic knowledge. This is good news, because in many areas of science applied research cannot progress further without such knowledge. Most of the emphasis will be in the physical sciences having responsibilities in the development of missiles and satellites, but it is hoped some of the efforts will spread into the biological sciences. We need much more research on the biological, physiological, and behavior characteristics of the mosquitoes that cause us trouble.

You probably know that the Agricultural Research Service of the U. S. Department of Agriculture has decided to encourage and stress basic research in plant and animal studies. To implement this, pioneering research laboratories have been set up in different areas of work of the Department. The Entomology Research Division has founded two such laboratories, one on insect physiology and the other on insect pathogens. Both laboratories are located at Beltsville. The physiology group is headed by Dr. W. E. Robbins, formerly a member of our Corvallis, Oregon, laboratory. He will be assisted by six physiologists to work on broad problems relating to toxicology, physiology, resistance, nutrition, and physiological reactions of insects to chemicals. The insect pathogens laboratory, headed by Dr. C. G. Thompson, will concentrate on the possible use of diseases to combat noxious insects. It is expected that these two laboratories will make contributions that can be applied to control of many insects, including mosquitoes. Several states are conducting research of a basic nature and the U. S. Public Health Service has plans for strengthening work on insect resistance, especially in disease vector species.

I believe we can expect a greater need for mosquito control. For example, the population in the United States is growing at the rate of over 4 million people annually, and it is estimated that by 1965 we will have nearly 200 million persons. In my opinion there will be just that many more people to be affected by mosquitoes and related arthropods and it will require expanded control activity and more personnel. Migration of the expanding population from towns and cities to the countryside will certainly have an important effect on mosquito control. This movement of populations away from cities increases the size of the areas that need protection against mosquitoes. Adjustments in the

size of mosquito-control districts and in approaches to their control must certainly be made in many areas.

The use of water to irrigate crops is increasing by leaps and bounds in the West, and also in the humid to semihumid East. Whenever crops are irrigated mosquito problems are created. Research by entomologists, irrigation engineers, and agronomists is needed to develop efficient water management methods which will minimize these problems. There seems to be a growing interest in the relationship of irrigation and mosquito production.

In the last few presidential reports to the Board I have noticed certain suggestions for improvements in A.M.C.A. affairs. There is no question that we can improve both as individuals and as an organization but this usually requires work. The only place where success precedes work is in the dictionary. There are several areas where we should strive to become more proficient. The following suggestions are not new but seem worthy of consideration:

1. Encourage regional directors to greater influence, service, and coordination in their respective districts through closer contact with members, problems, and current events, and promoting superior mosquito control and research in old but especially in new or forming districts. The directors should also have closer liaison and more frequent communication with the A.M.C.A. officers.

2. Arrange for more A.M.C.A. and mosquito-control exhibits at regional, state, and national entomological and other meetings. The fine exhibit by A.M.C.A. members at the Entomological Society of America meeting at Memphis in December attracted wide attention and did much to acquaint people with the objectives and achievements of our organization. Let's have more of these good exhibits.

3. Urge that more articles or news notes appear in *Mosquito News* on operational techniques, advantages and disadvantages of certain types of equipment and evaluation of our practical control efforts. It seems highly important to broaden the base of information given in our journal. I have heard members express a desire for more information on effectiveness of certain types of sprayers, ditching equipment and other equipment, and everyday control procedures. Short items rather than full-length papers might be more desirable in most cases.

I want to express sincere gratitude and thanks to the officers of this Association, the chairmen and membership of the various committees, and the general membership for loyalty, support, and earnest and hard work during the year. It has been amazing to me to see the dozens and even hundreds of real hard workers and promoters for the cause of good mosquito control. It is impossible to name the numerous people who are daily contributing to the welfare and strength of the organization. However, I cannot refrain from pointing out the excellent management job that your Executive Secretary, Ted Raley, is performing. He puts in an enormous amount of work on the affairs of the Association. The work of Don Collins, as Editor of *Mosquito News,* is outstanding, and his untiring efforts have made *Mosquito News* the respected Journal it is today. Lester Smith's activities in handling the job of Treasurer are also outstanding, and I am sure every one recognizes his efficient processing of records and funds has had much to do with the success of our organization. Your President-elect, Cdr. John M. Hirst, and Vice-President, Dr. Archie Hess, have a deep interest in mosquito control and certainly have been working hard for the welfare of our Association. Dr. W. E. Bickley has done a tremendous job in organizing and leading the group responsible for this excellent meeting in the Nation's Capital. We owe a debt of gratitude for his efforts.

A. W. LINDQUIST, *President*

ATTACHMENT #3

AMERICAN MOSQUITO CONTROL ASSOCIATION, METUCHEN, NEW JERSEY

SUMMARY OF CASH RECEIPTS AND DISBURSEMENTS

Treasurer's Account, Year Ended December 31, 1957
Audited by Nathan Lipman, C.P.A.

RECEIPTS		General Account	Special Publications
Balance on deposit—January 1, 1957		$ 5,228.59	$ 927.30
Dues and subscriptions	$5,428.17		
Advertising	3,093.05		
Back issues	44.50		
Reprints	842.23		
Good Neighbor Club	515.00		
Bulletins	55.00		
C. T. Williamson—transfer of funds			$1,000.00
Contribution—Florida Association	1,495.00		
Unidentified deposits	7.33		
Other receipts	1.44	11,481.72	1,000.00
		$16,710.31	$1,927.30
DISBURSEMENTS			
Printing of *Mosquito News*, reprints and mailing charges	$8,840.15		
Office supplies, expenses, etc.	346.33		
Postage	276.86		
Fidelity bonds	23.75		
Traveling expenses	500.00		
Convention expense—1958 (Dr. Bickley)	150.00		
Examination of Treasurer's records	70.00		
Refund to subscribers	10.00		
Bank charges	1.61		
Checks returned (redeposits included in receipts)	143.85	10,362.55	0
BALANCE—December 31, 1957 (on deposit—Commonwealth Bank of Metuchen, Metuchen, New Jersey)		$ 6,347.76	$1,927.30

ATTACHMENT #4

Report of Editor of *Mosquito News* on Volume 17 (1957)

Presented below are the statistics on the printing of *Mosquito News,* Volume 17. In addition, the Editor would like to make a few remarks. He is writing this report just as the final contributions from the Associate Editors are being assembled for the March, 1958 number, which will be Volume 18, No. 1. This prompts him to take this opportunity to thank them on his own behalf, and on behalf of the Association for their unselfish and untiring efforts during the year just past and all the other years past.

The letters of commendation and complimentary remarks received by the Editor are really meant for the Associate Editors, each working diligently and intelligently, often without any recognition, and always without the recognition they deserve.

Helen Sollers, now in a research branch not specializing in mosquitoes, has nevertheless continued, singlehandedly, to make the Bibliography Section one of the outstanding features of its kind in any scientific periodical. Several subscribers have stated that that is the department they turn to first, and that it alone is worth many times the subscription cost in time saved in literature search. This is a difficult section to compile, difficult to type, difficult to set up in type, and difficult to proofread. Our printers as well as Miss Sollers deserve credit for an outstanding achievement in this department.

Helen Louise Durkee, likewise now no longer in mosquito work as a profession, has made her department also one of the most valued in our journal. She seems to have a very special knack for obtaining reviews from the busiest people, who of course, are at the same time authorities in their fields and therefore the best possible persons to give authoritative resumés and critical reviews. And when these fail she does them herself. We cannot think of anyone who has shown more devotion to A.M.C.A. and *Mosquito News.*

Austin Morrill obviously enjoys compiling his department almost as much as his readers enjoy reading it, and the editorial office always awaits his contributions with the greatest interest. *Mosquito News* has always tried to reach every type of reader, from the wielder of the spray boom and the operator of the dredge, to the wielder of the micro-pipette and the manipulator of the scalpel. Austin, as Horace said of Death, knocks indiscriminately on the doors of all, (pardon the allusion, Austin) and we never know what or whom he will find to present, or where or when or how he finds it all out.

Dr. Travis and Dr. McDuffie, and the authorities whom they consult, constitute an ever present, ever helpful, always willing, indispensable source of advice for the Editor. By the very nature of things in a journal such as ours, the editor has to take and should take the final responsibility for what appears in print in the *News.* However, he would like to state here, that if what appears is good, it is to the credit of the contributors and the Associate Editors; if it is bad he must take the greatest share of the blame himself.

The Editor therefore takes the opportunity, in presenting his annual report, to accept in the name of the Staff of *Mosquito News* and the contributors, such compliments as have come to us, and at the same time to accept for himself the occasional criticisms and suggestions for betterment, with the promise to give them his most sincere consideration and attention.

Issue	No. Printed Vol. 16	No. Printed Vol. 17	No. Pages Vol. 16	No. Pages Vol. 17	Cost Vol. 16	Cost Vol. 17
March	1450	1450	68*	84*	$1720.96	$1917.26
June	1450	1450	152	88	3006.05	1846.69
September	1450	1450	80	116	1630.99	2331.26
December	1450	1500	92	120	2035.36 [1]	2454.44
Total	5800	5850	392	408	$8393.36	$8549.65

* Includes Index.

Less payments for extra pages, extra tables, illustrations, etc.	$157.25	
Payment made by authors for corrections in proof which exceeded allowable number	5.00	162.25
		$8387.40

	No. Pages Vol. 16	No. Pages Vol. 17
Proceedings Papers	115	131
Articles	107	115
Operational and Scientific Notes	11	4
Editorial	1	3
Association News	22	24
News and Notes	20	15
Reviews and Abstracts	11	6
Bibliography	33	31
Advertising	71	75
Miscellaneous	1	4
	392	408

D. L. COLLINS, Editor

ATTACHMENT # 2

REPORT OF NOMINATING COMMITTEE AMERICAN MOSQUITO CONTROL ASSOCIATION

The members of the Nominating Committee, duly appointed by the President and approved by the Board of Directors, nominate for the coming year the following slate of officers:

For President, Comm. John M. Hirst
For President-Elect, A. D. Hess
For Vice President, Dan Jobbins
For Recording Secretary,
Arthur F. Geib

For Regional Directors:

South Atlantic Region, J. A. Mulrennan
Northwest Central Region, J. E. Graham
Southwest Central Region,
Don Micks
North Pacific Region, LaVerne Miller
Mexico, Central and South America,
Luis Vargas

The above nominees have agreed to serve, if elected.

Respectfully submitted,

ALLEN S. WEST
ROBERT L. ARMSTRONG
P. B. BROCKWAY, JR.
R. W. BUNN
JAY E. GRAHAM
C. A. VIESER
JOHN H. HUBER
E. CHESTER ROBINSON
LUIS VARGAS
FRED H. STUTZ, *Chairman*

ATTACHMENT #5

Report of the Standing Committee on Publication of *Mosquito News*

Mosquito News, in addition to serving as the official organ of the Association, has established an international reputation as a vehicle for authoritative scientific papers relating to mosquitoes and their control, and as a medium for exchanging information of practical interest among control workers. The Editor, Dr. Don Collins, and other members of the editorial staff, have in large measure been responsible for this good reputation. They give their services to the American Mosquito Control Association without compensation and perform this work in addition to their regular professional duties. Your committee have given thought to possible ways of making their task easier.

In the past it has apparently been assumed that any papers that are presented at the annual meetings of the Association would automatically be published as part of the Proceedings. Your committee has considered this situation and recommends that all papers for publication in *Mosquito News,* whether part of the Proceedings or not, must conform to the literary and scientific standards of the journal. The acceptance of papers should be left to the discretion of the Editor and his editorial associates and advisors, and consideration might be given to the establishment of an Editorial Board or Review Committee, to assist in screening papers delivered at the annual meetings, and to deal with other papers that the Editor thinks should be critically examined by appropriate authorities.

This would assist the Editor in weeding out papers of doubtful value or questionable content. The Proceedings could be made complete in such cases by substituting short summaries for the papers in question. By such means the good name of *Mosquito News* would be maintained and economies affected in publication.

Attached to this report is the draft of a statement entitled: "Publication Policies and Manuscript Rules for *Mosquito News*" prepared to assist in reducing the load of work of the Editor and his associates and to help offset increasing costs of publication. This embodies the rules and regulations concerning manuscripts, printed on the inside back cover of *Mosquito News,* and also includes helpful material from the publication requirements of the *Journal of Economic Entomology* and other scientific journals.

The increasing number of papers received by the Editor requires that authors exercise more care in following the forms desired by the journal, and the increasing cost of publication requires that they prepare their manuscripts as concisely as possible. Accordingly, it is recommended that this or a similar statement, if approved, be published in *Mosquito News* to guide and assist authors in attaining these objectives.

W. E. Bickley
P. Bruce Brockway
Kenneth L. Knight
C. R. Twinn, *Chairman*

Mosquito News

(Official Organ of the American Mosquito Control Association)

Publication Policies and Manuscript Rules

The primary criteria for approval of an article for publication in *Mosquito News* are the [scientific] merit of its content and the clarity and conciseness of its presentation. No manuscript that has been published elsewhere, either wholly or in essential part, will be accepted. Also, it is understood that articles submitted will not be offered for simultaneous publication in other journals without the consent of the Editor.

Preferably, manuscripts should be accompanied by the written approval of a person or persons familiar with the subject. The Editor may submit the manuscript to one or more reviewers. Subsequently the author may be given an opportunity to revise his paper in accord-

ance with the reviewers' comments. If revisions are made all pages of the original manuscript, as well as any retyped ones, must be returned to the Editor. This procedure is followed solely for the purpose of improving the quality of articles and to reduce publication costs. Papers are unacceptable if conclusions are obviously unsound or based on faulty experimental methods or inadequate data. Acceptable papers must be in accord with the rules and suggestions printed in *Mosquito News*. When a paper is unacceptable the Editor will return it to the author with an explanation for not accepting it.

In general, preference in publication is given to authors who are members of the Association and subscribers to *Mosquito News*. If an article exceeds six printed pages, the author may be asked to pay for the additional pages at cost. Articles are ordinarily published in the order received, except for material given priority by the Board of Directors or the Editor's discretion. Date of receipt is that date on which copy is accepted in final form for publication. Immediate publication of acceptable manuscript out of turn may be secured by payment of the cost of printing and engraving ($11.00 to $13.00 a page, or more, depending on make-up and current costs).

Preparation of Manuscripts. For the ribbon copy, use paper of medium weight and good quality; flimsy paper is not satisfactory. Preferably use paper 8½ by 11 inches. Type on only one side of the paper and leave ample margins. *The ribbon copy is required for the printer. Double space all typed material, including text, footnotes, tables, captions, references, etc.* Number consecutively all pages in the manuscript, including those for tables and captions for illustrations. Use paper clips, *not staples or pins,* to fasten manuscripts. Mail the manuscript flat, not folded or rolled.

In the title indicate the subject of the paper clearly but concisely. Give the official address and indicate the professional status of the author or authors in a footnote on the first page. Keep text footnotes to a minimum and number them consecutively throughout the paper. Center heads should be avoided if possible; if used they should be brief and clear. Use sideheads for subheads.

Tables. Tables are expensive. Reduce them to the simplest form and do not use them if text or illustrations give the same information. The author may be charged for extra composition for tables. Give each table a clear concise heading stating its contents. Use a double horizontal line immediately below the title of the table and a single horizontal line below the column headings and at the bottom of the table. Use no other horizontal lines and no vertical lines. Reduce the number of columns to a minimum. Type each table on a separate sheet and place it at the end of the manuscript. Show where the table is desired in the text by writing: "Table 1 near here" encircled with a line.

Illustrations. Illustrations are expensive and are accepted at the discretion of the Editor and only when they contribute substantially to the information presented in the paper. They are required to contain material that is not given in tables or that is not more readily given in tables or summarized in the text. They should be clear and obviously suitable for reproduction. Authors may be charged for engravings if more than 3 are required, or if their use results in excess pages. Make the lines and letters and figures on drawings heavy enough to stand the required reduction. *Labels and key letters should not project into the margins in such a way that they cause greater reduction than would otherwise be necessary.* Drawings should be on pure white or light blue cross-hatched paper. Original drawings are preferred. It is advantageous also to include a photographic copy for transmittal to reviewers. Place on the back of each illustration the name of the author, the title of the paper, and the figure number as used in the text. Note that cracks and marks made by paper clips or pressure of writing ruin photographs for reproduction. Type the captions for illustrations by themselves at the

end of the manuscript, in paragraph form. Show where the figure is desired in the text by writing: "Fig. 1 near here" encircled with a line.

References Cited. Citations should be given in the text and the references placed in a list typed double spaced on a separate sheet of paper at the end of the text. Arrange them alphabetically by author's last name followed by the author's initials, year, title, name of publication, volume, and pages, in the order named. Abbreviations used in references should conform to those published in *Biological Abstracts* (Vol. 29(5):V–XXV, May, 1955, and any subsequent revisions of this list).

Proof. Galley proofs will be sent to authors or their representatives to read and correct before publication unless the Editor is otherwise instructed by the author. Alterations should be limited to the correction of typographic and factual errors. Authors may be charged for correction of errors in galley proofs for which the authors are responsible. The corrected proof must be returned promptly to the Editor or the article will not be printed in the current issue or may be printed without benefit of author's corrections.

Summary. A summary is desired for all but very short papers.

Abstract. When returning corrected galley proof contributors are asked to send an abstract of the article for transmittal to *Biological Abstracts*. This should be kept within 250 words and should not exceed 3 percent of the original length.

Reprints. No free reprints are supplied. The author or the agency by which he is employed should order them when returning the galley proof. The schedule of prices for reprints will be found on the inside back cover of *Mosquito News*.

ATTACHMENT #6

REPORT OF THE FINANCE COMMITTEE

The annual budget prepared by the Treasurer has been examined and the committee recommends its adoption.

One of the basic functions of this committee is to give thought to the development of methods for increasing revenue to the Association. In the interest of brevity the committee directs the attention of this body to just a few of these resources which are especially close to home. First, there is the development of an "improved supplier interest."

A fair share of convention expenses is borne by fees charged exhibitors and demonstrators of equipment and materials, who are undoubtedly very hopeful at each of these meetings that the importance of their products will impress a goodly number of the delegates present. Aside from the good fellowship arising from personal contact at these affairs, their presence or showing may conceivably be less attractive to them unless some added inducement is forthcoming. Judging from the reactions this committee has had from a number of district trustees and technical directors, many of the representatives from the field or practical side of our business leave the national meeting with a feeling of disappointment because of the limited amount of time and attention the programs have devoted to this important part of our interests.

Following is a summary of the committee's opinions on these subjects:

The scope of the annual meetings should be broadened to include more opportunity for the advertisers and exhibitors to get their message across. This would benefit both suppliers and users, and might bring in more revenue both by maintaining and increasing the interest of the suppliers in advertising and exhibiting, and by encouraging greater attendance at meetings.

There should be more encouragement of program participation by those interested primarily in field work and practical application, to balance the presentation of more technical papers. The committee believes the achievement of such a balance might also stimulate attendance.

Approval was expressed of Don Johnson's work as chairman of the Member-

ship Committee, and the Finance Committee suggests that the Membership Committee should be entitled to support not only from individuals as such but also from all potential members, such as District board trustees, health officers, universities, manufacturers of field equipment, producers of larvicides, etc.

Although the Association is in sound financial condition, there is no financial leeway for any type of expansion or unusual expense, however justifiable, such as help for the secretary and treasurer in assisting the Membership Committee, or help in financing the national meeting, which under present conditions depends on an organized local group to promote and hold a meeting.

Therefore, the Finance Committee, in order to improve the Association's financial condition, suggests that Board consideration be given to the thoughts advanced above and to the following specific suggestions:

1. *Increase New Membership Fees and Annual Dues.* Our cost of operation, small as it is, has been affected by inflation. Considering the value of what we have to offer to each member of our profession and to the world at large, it is indeed a small fee that we charge. The committee believes that there should be a nominal increase in both of these fees.

2. *News Advertising Campaign.* Many of our members are using products of suppliers who do not advertise in *Mosquito News.* If these products fulfill the needs of these members it should not be too difficult to convince the supplier of the potentials of a broader application through an ad in *Mosquito News.*

3. *Program Advertising.* This has been a source of revenue in similar enterprises and we urge that the Annual Conference committees consider the possibilities.

4. *Grants-in-Aid.* This is a field that has been explored to a certain extent and eventually may prove profitable. There are some instances where outright grants for specific projects could be helpful and we understand that Bob Vannote is giving this matter his personal attention. The Finance Committee urges that advantage be taken of whatever resources become available, without, however, obligating ourselves beyond what is proper for the Association to accept.

5. *District Budget Assessment.* The raising of funds by assessment has been proposed. Local districts could consider this at the time their budgets are being prepared as money to be used for educational and informative purposes. The amount to be assessed would of course depend on the sums required by the A.M.C.A., but under any circumstance would be only a small fraction of the district total budget. Local legal limitations may have to be reviewed.

Your Committee on Finance make the above presentation in the hope that this board will seriously consider the appointment of a special studies group that will have the power to review these and kindred suggestions and make any formal proposals that will lead to accomplishing what has been suggested.

Respectfully submitted,

P. BRUCE BROCKWAY, JR.
G. W. EDDY
ROBERT L. ARMSTRONG
DAN F. BOYD
F. RAY BARRON, JR.
LESTER W. SMITH
CHARLES F. SCHEEL, *Chairman*

ATTACHMENT #7

REPORT

To: Directors, American Mosquito Control Association

Subject: Assistance from the Ford Foundation

Date: February 20, 1958

Acting with the approval of the Board of Directors, several conferences have been held with officials of the Ford Foundation relative to financial assistance to the American Mosquito Control Association. The conclusions of the conferences are as follows:

1. At the present time the scope of the

Foundation's activities do not include programs in the fields of natural science or engineering; however, an organization is now being set up for such projects.

2. Our general interest has been recorded to support such a program.

3. Submission of an application for assistance prior to October 1, 1958 could not be processed; consequently, would be rejected as the organization for projects in this field will not be operative until that time. No applications are held for future approval.

4. General facts relative to assistance:

a. Funds are appropriated to approved projects to accomplish a specific objective or to finance a program until it can become self-supporting.

b. Grants may be made for one or more years; however, ten is about the limit.

5. General facts relative to applications:

a. The proposal should contain the following:

1. A brief description of the sponsoring agency, its objectives, organization status and its authority to accept and administer grants.

2. The objective of the proposal.

3. Methods by which it is to be accomplished.

4. The period of time it is expected to take.

5. The funds required and an estimated budget in some detail.

6. The qualifications of the organizations or individuals involved, and the organizations' ability for tax-exemption privileges.

7. Whether similar projects have been undertaken previously.

8. Whether support has been, or is being, requested of other foundations. (The Ford Foundation is more willing to assist if funds are available from no other source.)

b. A representative of the sponsor should be available to meet with the Foundation's Board of Directors to discuss the program and answer questions.

6. Recommendations

a. That the Board fix its objectives for financial assistance; in what area, how much and how long.

b. That the Board appoint a Committee authorized to pursue financial assistance in accordance with the general policies.

c. That the Committee develop a program in accordance with the policies of the Board and file applications with other sources of assistance.

d. That on October 1, 1958 an application be filed with the Ford Foundation.

e. That the officers of the Association be authorized to sign such applications and contracts, should approval be granted.

ROBERT L. VANNOTE,
National Adviser

ATTACHMENT #8

REPORT ON ADVERTISING IN *Mosquito News* JANUARY 1, 1957 THRU DECEMBER 31, 1957

The figures below represent transactions during the calendar year 1957, for advertising in four numbers, Volume 16 number 4 and Volume 17, numbers 1, 2 and 3. (December 1956 and March, June and September 1957.)

Number of Active Accounts	27
Number of Pages of Advertising (exclusive of AMCA business)	70
Receipts	$3,141.15
Expenses:	
Postage, telephone, telegrams	$ 58.40
Printing, rate sheets, envelopes	31.20
Honorarium for stenographer	10.00
Total Expenses	$ 99.60

Respectfully submitted,
FRANCIS P. CREADON,
Advertising Manager

ATTACHMENT #13

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC., OFFICE OF THE TREASURER

BUDGET ESTIMATE 1958

PRESIDENT:			
Postage and stationery,	$ 50.00	$ 50.00	
SECRETARY:			
Postage,	125.00		
Printing, stationery and forms,	100.00		
Insurance bond,	5.00		
Telephone, telegrams,	10.00		
Other expense,	10.00		
Travel expense, Annual Meetings for all eligible members,	500.00	750.00	
TREASURER:			
Postage,	125.00		
Printing, stationery and forms,	75.00		
Telephone, telegrams	10.00		
Annual audit of books,	100.00	310.00	
EDITOR:			
Postage,	25.00		
Printing, stationery and forms,	25.00		
Telephone, telegrams,	25.00		
Printing *Mosquito News,* 4 issues, includes mailing costs,	8,425.00	8,500.00	
ADVERTISING MANAGER:			
Postage,	50.00		
Printing, stationery and forms,	35.00		
Telephone, telegrams,	25.00		
Other expense,	10.00	120.00	
LIBRARIAN:			
Postage,	50.00		
Stationery,	20.00	70.00	
BUSINESS MANAGER:			
Postage,	50.00		
Stationery,	10.00	60.00	
OTHER EXPENSE:			
Contingencies	340.00		
Educational Exhibit	200.00	540.00	
TOTAL ESTIMATED BUDGET (1958)			$10,400.00

ESTIMATED REVENUE, 1958

	ACTUAL, 1957	ESTIMATED INCOME, 1958
Dues and subscriptions,	5,428.15	6,000.00
Advertising	3,093.05	2,800.00
Contributions from individuals and Associations	1495.00	1,100.00
Good Neighbor Club	515.00	500.00
TOTAL REVENUE	$10,531.20	$10,400.00

Respectfully submitted,
LESTER W. SMITH, *Treasurer*

ATTACHMENT #9

Good Neighbor Club, American Mosquito Control Association, February 22, 1958

The annual campaign for 1958 Sponsors for the Good Neighbor Club, A.M.C.A., was launched in December, 1957. All 1957 Sponsors were contacted, soliciting continued support. All Good Neighbors were contacted inviting them to join A.M.C.A. or indicate their wishes for continued sponsorship. Letters of solicitation and blanks for adopting Good Neighbors were distributed in the December issue of *Mosquito News*. Dr. Lindquist made secretarial assistance available, equivalent to 3 man-days, for this initial drive. Dr. Collins handled the distribution through *Mosquito News*. These courtesies are acknowledged and appreciated.

Of the 113 Good Neighbors sponsored during 1957, two have elected to join A.M.C.A. and two have cancelled membership. Eight new Good Neighbors have been added. Two new countries have been added. There are 117 Good Neighbors from 48 countries to be sponsored during 1958. Names of 64 candidates are on the list waiting for Sponsors. Among these candidates are representatives from eight countries currently not reached by the Good Neighbor Club.

Of the 61 Sponsors of 1957, 42 have renewed sponsorship. Five new Sponsors have been added, totalling 47 who are sponsoring 82 Good Neighbors.

Those Sponsors who have not renewed for 1958 have been contacted again. The financial status of the Good Neighbor Club cannot be known until after receiving responses from these and potential Sponsors.

Recommendations for 1959 are:

1. Further investigate the possibility of the State Department making funds available for sending subscriptions overseas, action initiated by A. D. Hess and D. R. Johnson.

2. Provide for sending back issues of *Mosquito News* to Good Neighbors who request them.

Status of Good Neighbor Membership

	1957		1958	
	Sponsors	Good Neighbors	Sponsors	Good Neighbors
Commercial	14	50	9 renewed 1 new	29 (3 new)
MAD & State Assoc.	16	24	12 renewed	18
Individuals	31	39	21 renewed 4 new	35 (5 new)
Totals	61	113	47	82

Financial Status

Operating Fund			
Receipts:			
Cash transfer from A. D. Hess, 7/12/57	$125.00		
Van Hovenberg Fund	140.63		
From 1958 Sponsors	367.50		
Bank Deposits		$633.13	
Committed by Sponsors	25.00		
Expenditures:			
Paid Directly to AMCA Treasurer			
Orange Co. MAD	10.00		
N. Salinas Co. MAD	5.00		
Letterheads & Envelopes (Pd. 10/10/57)		36.50	
Bank Balance			$596.73
Stamps (not paid)	26.14		
Typist (35 hrs. @ 75¢/hr. not paid)	26.25		

3. Allocate $50.00 for clerical assistance for the Chairman of the G.N.C.

Respectfully submitted,
ROBERT L. VANNOTE
HELEN SOLLERS
ROWLAND E. DORER
GORDON E. SMITH
WILLIAM J. BUCHANAN
ALBERT W. BUZICKY
C. DONALD GRANT
LESLIE D. BEADLE
ARCHIE D. HESS
CARROLL N. SMITH
ERNESTINE B. THURMAN, *Chairman*

ATTACHMENT #10

REPORT OF THE SALES OF MISCELLANEOUS PUBLICATIONS COMMITTEE

During the past year the members of the Committee on Sales of Miscellaneous Publications have devoted considerable time and effort to promoting sales of the bulletins of the Association, particularly Bulletin No. 3. This task was undertaken without great expectations because the latest bulletin has been available since January 1955 and most of the interested people would presumably have obtained copies. The committee was gratified to learn from Mr. Williamson that an increase in sales had resulted from their efforts.

Advertisements have been inserted free of charge in several publications and postcards with information relative to the bulletins are being sent to colleges and universities throughout the country. Members of the committee are trying to promote sales by contacting groups and individuals in their areas and are having some success. Continuing efforts on the part of the committee and individual members of the association are needed to sell the remaining copies of the bulletins.

Respectfully submitted,
OSMOND P. BRELAND
BRIAN HOCKING
C. T. WILLIAMSON
FRANKLIN C. WRAY
JAY E. GRAHAM, *Chairman*

ATTACHMENT #11

REPORT OF MEMBERSHIP COMMITTEE—1957

During 1957 this committee revised the Application for Membership Form. An editorial entitled "A Young Adult and a Teenager," which urged all members to recruit new members, was included in Volume 17, Number 3, September 1957, *Mosquito News*. One copy of the new Membership Form, which is printed on blue stock, was included with each copy of this issue of *Mosquito News*.

A letter of invitation to membership (attached) was prepared and sent to 180 members of the Medical and Veterinary Section of the Entomological Society of America who are not members of the A.M.C.A. In addition, the A.M.C.A. Board of Directors, Regional Directors and other members distributed many membership forms to prospective members. A special A.M.C.A. exhibit was prepared and displayed at the 5th Annual Meeting of the Entomological Society of America in Memphis during December. Membership Forms were available at this exhibit which was assembled by George Hutton and other members.

The membership has increased during the past year, as evidenced by the mailing list. There were 1298 subscriptions of *Mosquito News* as of the December 1956 issue mailing, and 1384 subscriptions for the December 1957 mailing. This is a net increase of 86 subscriptions for 1957. With the continued support of our membership unprecedented growth of the Association will occur during 1958.

Respectfully submitted,
DONALD R. JOHNSON,
Chairman, Membership Committee

ATTACHMENT #12

STANDING COMMITTEE ON PUBLIC RELATIONS

The Committee was circularized and asked to vote on the acceptance of a design for an Association Seal and Pin. Also, they were requested to give their ideas on

other Committee projects. The returns were very complete and many suggestions were made. From these a tentative report of the Committee was made up and sent to each member for his comments. On a majority count the tentative report was approved in toto. However, some very pertinent comments were made concerning some of the items and they have been included in the final report for your consideration.

1. Your Committee feels that an increase of one dollar ($1.00) in dues is necessary and makes such a recommendation. This was unanimous.

2. Based on the experience gained at the E.S.A. Meeting in Memphis where the A.M.C.A. had an exhibit, it is felt that the Association should construct a suitable exhibit which could be shown at meetings in various parts of the country. This exhibit should be portable so that it can be easily shipped or carried in an automobile and would have as its main purpose the promotion of the A.M.C.A. There was strong support for this project.

It is recommended that the A.M.C.A. appropriate $200.00 for the construction of such an exhibit.

3. Your Committee feels that a set of suitable posters which could be sold to the various Mosquito Control organizations would have a ready market and it recommends that the Board of Governors make $50.00 available to produce several sample posters. There was some doubt by one member whether this could be done effectively.

4. The idea of an International Advisor was suggested and inasmuch as Harry Stage is so well acquainted abroad his name was considered for the post. Several members expressed an opinion which was not against the idea, but they felt that there might be some confusion with the operation of the Good Neighbor Club and, also there might be some conflict with the duties of the National Advisor. Therefore, the Committee recommends that this matter be considered by the President and Board for proper action.

5. Your Committee has determined a need for a special publication in the form of a handbook for field operators and recommends that this matter be turned over to the Special Publication Committee with a recommendation that work toward this end be started.

Respectfully submitted,

E. J. Beidler
W. J. Buchanan
Harry D. Pratt
Francis P. Creadon
Harry H. Stage
Ernestine Thurman
Don R. Micks
Robert Hammon
R. E. Dorer, *Chairman*

ATTACHMENT #14

Report of Research and Development Committee for 1957

The Research and Development Committee made a belated effort to assemble information on new research developments in mosquito control during 1957, with the idea of determining the present status of research and future research needs. With this information at hand it was felt that our committee might undertake to promote closer cooperation among the major research agencies and thereby hasten progress in the field of mosquito control. The response was so unenthusiastic that we failed to achieve our objective. However, we have summarized the highlights of research available to us and are reporting them by agencies:

U.S.D.A., Orlando, Florida

Research at the Orlando, Florida, laboratory is concerned primarily with the development of new insecticides for use in mosquito control. Approximately 1,000 new chemicals are screened annually and as a rule 10 or 12 are found that are worthy of field evaluation. At the present time some 25 or 30 promising materials discovered during the period of 1955–57 are in various stages of evaluation in the field.

In small plot tests against *Anopheles* larvae seven materials have given results comparable to DDT, namely, the 2,4-dimethylbenzyl and 6-bromopiperonyl esters of chrysanthemumic acid, Guthion, Thimet, *S-p*-chlorophenylthiomethyl-*o,o*-diethyl ester of phosphorodithioic acid and two Bayer compounds. In field tests against resistant salt marsh larvae granular formulations of 4 insecticides applied by airplane gave 97 to 100 percent control as follows: Bayer 21/199 at 0.1, malathion at 0.25, chlorthion at 0.5, and Dipterex at 0.75 per pound per acre. Oil solutions applied by air were less effective.

Research in the San Joaquin Valley, in cooperation with the California Bureau of Vector Control, showed that Dipterex at 0.5 p.p.m. and phosdrin at 1.0 p.p.m. controlled larvae for ½ mile from the point of introduction into irrigation water. The search for more effective water soluble materials is being continued.

Studies on the rate of release of different concentrations of several insecticides from various types of granular materials indicate that insecticides have a variable rate of release at different concentrations in the same as well as different diluents. This means that precise formulation of granular formulations is far more important than generally believed.

In field tests of aerial sprays against salt marsh adults, excellent control of heavy populations was obtained with parathion at 0.025 pound per acre and malathion and Diazinon at 0.05 pound per acre. One of the esters of chrysanthemumic acid gave 88 percent control at 0.1 pound. Bayer 21/199, Dicapthon (Am. Cyanamid 4124), and Dipterex at 0.1 and 0.25 pound per acre were inferior to the other named materials.

As residual treatments malathion and Diazinon appeared to be about as effective as DDT over a 3-month test period against *A. quadrimaculatus*. Dicapthon was only slightly less effective and chlorthion, Dipterex, and Dow ET-57 also showed promise. Future developments from this program will doubtless be of interest and value to malaria control organizations faced with the problem of DDT-resistant *Anopheles*.

"Mosquitoes of the Southeastern States" has been revised by Drs. King, Bradley, and Smith. This valuable publication should be available late this year.

U.S.D.A., Corvallis, Oregon

Research on mosquito control at Corvallis, Oregon, includes (1) the screening of new insecticides against *Culex tarsalis,* (2) the field testing of promising materials against *Culex tarsalis* and flood water *Aedes,* (3) biology and control of mosquitoes in log ponds, (4) the control of adult mosquitoes in irrigated areas, and (5) the studies of resistant mosquitoes.

During 1957 approximately a dozen promising insecticides against *tarsalis* were found, the best of which were: Bayer 21/199, Am. Cyanamid 12008, Am. Cyanamid 12009, Thimet, and Guthion.

In field tests against *Aedes nigromaculis* in irrigated areas of the San Joaquin Valley in cooperation with the California Bureau of Vector Control, several chrysanthemumic acid esters were effective at 0.4 pound per acre. Am. Cyanamid 12008 at 0.05 and Korlan (Dow ET-14) at 0.3 pound per acre, gave 97 and 100 percent control. Against *C. tarsalis* the 6-bromopiperonyl ester at 0.4 pound per acre gave 82 percent control, whereas the same dosage of the 6-chlorophenyl ester gave only 44 percent.

In log ponds heptachlor at 1, 3 and 6 pounds per acre prevented breeding for 5, 8, and more than 10 weeks, respectively. Applications of 1, 3 and 6 pounds per acre of DDT and malathion were effective for about 3, 5, and 6 weeks, respectively. The principal species in log ponds were *Culex pipiens, C. stigmatosoma* and *Culiseta incidens*.

An intensive study was made of the nature and characteristics of a number of log ponds which indicated that abundance of debris, water movement in and out of ponds, and water levels all had a bearing

on breeding. Since all of these are manageable factors it would appear possible to alter them to create unfavorable conditions for breeding.

In tests conducted in cooperation with the California Bureau of Vector Control community fogging with 5 percent malathion with 3 percent lethane or 0.08 percent pyrethrins failed to give satisfactory control of *Culex tarsalis* adults, but was highly effective against *Aedes* species. These results point up the need for more effective methods and/or insecticides for controlling adult *C. tarsalis,* an important vector of equine encephalitis.

Florida State Board of Health Laboratory

The program of research of the Entomology Research Laboratory at Vero Beach includes the evaluation of mists, aerosols, and dusts for the control of adult mosquitoes, the development of new methods and materials for larviciding, and the management of salt marshes for the control of *Aedes* mosquitoes. Studies in 1957 showed that fogs and mists of malathion were highly effective against all species in all locations tested whereas DDT gave unsatisfactory control of *A. taeniorhynchus* everywhere.

A new larvicide consisting of paris green applied to vermiculite with an oil emulsion sticker proved highly effective against several species of anopheline and culicine larvae in both fresh and salt water breeding areas. This formulation affords a means of controlling resistant species of larvae with little hazard and only remote possibilities of the development of arsenic resistance.

The impoundment of water by diking has been found to be an effective means of eliminating *Aedes* breeding on marshes where lack of tides renders ditching and channeling ineffective. Flowing wells are the cheapest means of flooding but pumps are necessary in some situations.

Research has demonstrated that dikes must be constructed in different ways to hold water in different types of soil. Methods of effectively ditching and filling certain types of marshes are being investigated. Excellent progress has been made in these investigations and findings are already being utilized to advantage in many coastal areas.

The Vero Beach Laboratory is also emphasizing research on the biology and ecology of mosquitoes and the effects of minnows and other predators on larval populations.

Tennessee Valley Authority

The research program of the Tennessee Valley Authority includes studies on resistance in *Anopheles quadrimaculatus,* the development of improved larvicides and methods of application for the control of *Anopheles* and flood water *Aedes,* and the ecology and economics of vector and pest species of mosquitoes in impounded areas. In addition, there is a continuing surveillance program to correlate *Anopheles* breeding rates and water level fluctuations in numerous impoundments.

Several methods of selection have thus far failed to produce significant resistance in *A. quadrimaculatus* and none has developed in the field despite the fact that DDT has been used for 15 years in practical control operations. Since resistance to dieldrin apparently has developed in some areas, the possibility is advanced that the response of *quadrimaculatus* to DDT pressure is different from that to dieldrin.

Larvicide research in 1957 showed that 30 percent DDT solution gave better control of *quadrimaculatus* than a proportionately larger volume of 10 percent solution. In tests against flood water species, dosages as high as 0.6 pound per acre of DDT gave very erratic results in meadow areas and 0.9 pound per acre was relatively ineffective in timbered areas.

Ecological studies in 1957 produced a wealth of information on the feeding and dispersal habits of *Anopheles, Mansonia,* and *Aedes* in relation to meteorological and environmental factors. While several tentative conclusions might be made from

data available further studies are indicated to accurately determine the influence of the various factors.

U. S. Navy, Bureau of Medicine and Surgery

In 1957 the U. S. Navy Disease Vector Control Center, Jacksonville, Florida, compared the relative efficacy of aerosols (fogs) produced from commonly used insecticide formulations alone and in combination with organic thiocyanates. The superiority of one formulation over another in reducing adult mosquito density was not clearly established in these tests as DDT, and even diesel fuel oil alone, produced results equal to or better than other more costly formulations. The effectiveness of the aerosols was directly proportional to the thoroughness of coverage, intensity and frequency of treatment, the accuracy of technique and operator experience and training.

At the U. S. Navy Medical Field Research Laboratory, Camp Lejeune, North Carolina, a prototype liquid dispersal unit for use on Marine Corps HRS and Navy HO4S helicopters was completed. The liquid dispersal device consists essentially of a pair of spray booms with Tee-jet nozzles extending out both sides of the fusilage in a delta design, with the pumping assembly and reservoir mounted within the cargo compartment. Work is also under way on the development of a device which will adequately disperse granulated insecticides.

U. S. Public Health Service

The Technology Branch of the Communicable Disease Center is engaged in all aspects of mosquito control, especially of those species involved in the transmission of diseases.

In 1957 laboratory and field studies of available commercial toxicants as residual treatments against *Anopheles quadrimaculatus* indicated malathion and parathion to be the most promising of the organophosphorus toxicants. Tests in animal-bated huts with dieldrin-resistant *A. quadrimaculatus* showed that malathion (100 or 200 mg./sq. ft.); malathion:dieldrin (100:25 or 50 mg./sq. ft.); malathion: DDT (100 or 200:200 or 100 mg./sq. ft.) and parathion (12.5 mg./sq. ft.) gave 100 percent mortalities for the entire observation period of 4 to 5 months.

The evaluation of a dieldrin wettable powder with or without a resin against *A. quadrimaculatus* adults indicated that incorporation of resin in the formulation did not improve the effectiveness of the deposits on mud surfaces. At field dosages, neither formulation gave satisfactory kill after 2 days aging.

In laboratory tests with *Aedes aegypti* larvae, field strains from Pensacola and Tampa, Florida, were shown to be susceptible to DDT but a strain from Cucuta, Colombia, was found highly resistant to that compound. The resistant strain succumbed readily to malathion and dieldrin treatments.

Studies of *A. quadrimaculatus* in Mississippi showed that dieldrin-resistant strains exist in localities 20 to 50 miles beyond the "Delta" area where exposure of the species to agricultural insecticide treatments was considered to be maximum.

Preliminary tests of malathion dusts versus sprays for space treatments against adult salt marsh mosquitoes indicated that dusts gave higher kills of the mosquitoes and better dispersal of the toxicant. Effective mortalities of caged specimens were obtained with dosage rates of 0.2 to 0.4 lb. per acre.

Research by Other Organizations

A number of states are known to be conducting extensive research to develop improved methods and materials for the control of their own mosquito problems. New Jersey has a continuing program of research to develop more effective larvicides and adulticides, as well as methods of managing marshes to discourage mosquito breeding and to encourage wildlife

production. In California, special emphasis is being given to the development of more effective methods of source reduction and water management as well as new larvicides for the control of DDT- and malathion-resistant *Culex* and *Aedes* species breeding in irrigation waters. Other states doubtless have research programs designed to provide solutions to their own special problems.

Conclusions

As indicated in the introduction the Research and Development Committee failed to achieve its objective of compiling a complete report on the status of research on mosquito control. Nevertheless, our limited survey convinces us that research on mosquito control is not being neglected by the organizations contributing to this report. Excellent progress was made in 1957 in finding promising new insecticides and procedures for future use in mosquito control. Other non-reporting research groups have doubtless made significant progress. We therefore conclude that the limited research by various organizations is keeping pace with many of the current needs of mosquito control. However, augmentation in selected areas could provide increased prospects of obtaining even more adequate knowledge of mosquitoes and their ecology and accordingly their control.

Effective mosquito control is no longer entirely dependent upon the findings or advice of major research groups. Today a majority of district control programs are directed by trained entomologists and sanitary engineers who are capable of independent research and of devising methods of control best suited to solve specific local problems. The improvement in the caliber of the directors through training and/or experience has unquestionably resulted in more effective mosquito control. This committee believes that the employment of trained directors will insure maximum progress in mosquito control in future years.

Recommendations

The foregoing conclusions are made with the idea of assuring the Board that research on mosquito control is on a reasonably sound basis and good progress is being made. The Committee on Research and Development has had little influence in promoting research to its present level and does not feel that it needs to promote research as long as the current research effort meets the immediate needs for effective mosquito control. We therefore recommend that the Committee on Research and Development be inactivated as a "standing committee" and that the President of the Association be given the prerogative of reactivating this committee to function in this capacity if and when the need arises for investigations on specific problems.

Respectfully submitted,

W. C. McDUFFIE, *Chairman*
KENNETH QUARTERMAN
COL. RALPH BUNN
RICHARD PETERS
D. MANLEY JOBBINS
M. W. PROVOST
WM. R. HORSFALL
KENNETH L. KNIGHT
EUGENE J. GERBERG

ATTACHMENT #16

REPORT OF COMMITTEE ON BYLAWS

There was only one proposed amendment to the bylaws offered during the year. Correspondence by the members of the committee indicated that the matter was controversial; the chairman, therefore, suggested that action on the matter be held in abeyance until the annual meeting at which time the entire committee might consider the proposal.

The committee met at noon on Monday, February 24, 1958, to consider the proposal to amend the bylaws whereby the election of officers would be by mail ballot rather than the present method. After a thorough discussion the following recom-

mendations were adopted by the Bylaws Committee.

1. The Bylaws Committee recommends to the Board of Directors that a poll be made by mail to determine whether the membership of the Association wishes to continue the method of election of officers as now practiced or change to mail ballot.

2. The Bylaws Committee recommends that the results of this poll be made available to the 1958 (next Bylaws Committee) in time for said committee to take appropriate action and to report such action at the 1959 annual meeting of the Association.

Respectfully submitted,
DOYLE REED
T. G. RALEY
R. L. VANNOTE
C. F. SCHEEL
R. E. DORER
K. D. QUARTERMAN
B. B. PEPPER, *Chairman*

ATTACHMENT #17

Nominating Committee — 1958: A. W. Lindquist, Chairman, U.S.D.A., Entomology Research Branch, Plant Industry Sta., Beltsville, M.D.—**Southeast Central;** E. J. Stansfield, 917 Riverwood Ave., Fort Gerry, Manit., Canada—**Canada;** C. T. Williamson, Yaphank, L. I., N. Y.—**North Atlantic;** William W. Warner, 2213 Fogarty Ave., Key West, Florida—**South Atlantic;** W. J. Buchanan, P. O. Box 30, Harvey, Illinois—**Northeast Central;** G. C. Collett, 401 City & County Bldg., Salt Lake City, Utah—**Northwest Central;** Dr. Paul R. Meyer, 3801 Lakeshore Drive, Port Arthur, Texas—**Southwest Central;** Gaines W. Eddy, P. O. Box 332, Corvallis, Ore.—**North Pacific;** G. Edwin Washburn, P. O. Box 629, Turlock, Calif.—**South Pacific;** Dr. H. P. S. Gillette, P. O. Box 556, Port of Spain, Trinidad, B.W.I.—**Mexico, Central & South America.**

ATTACHMENT #18

REPORT, RESOLUTIONS COMMITTEE

BE IT RESOLVED: That the American Mosquito Control Association desires to express and record its appreciation and thanks:

1. To the Southeast Central Region, the Virginia Mosquito Control Association and members of the Program and Local Arrangements Committees for the excellent preparations and arrangements provided which have contributed so largely to the success of the Fourteenth Annual Meeting of the Association at Washington, D. C.

2. To the Walter Reed Army Medical Center, the National Institutes of Health, and the Agricultural Center, Beltsville, for their cooperation in arranging interesting and stimulating field trips.

3. To the management and staff of the Willard Hotel for the excellent facilities and services provided during the meeting.

4. To the Editor and staff of *Mosquito News* for their exceptional team effort in maintaining the high professional standard of the Association publication.

5. To the officers, National Advisor and Regional Directors for their generous and effective service to the Association during the past year.

6. To the Standing Committees for their many and diverse contributions in the furtherance of the objectives of the Association.

7. To all those who presented papers, or exhibits, or in other ways contributed to the success of the meetings.

RESOLUTION #2

BE IT RESOLVED: That the Association express its sorrow over the passing of several active members during the past year.

ATTACHMENT #15

AMERICAN MOSQUITO CONTROL ASSOCIATION, MISCELLANEOUS PUBLICATIONS

FINANCIAL STATEMENT

December 31, 1957

CHECKING ACCOUNT

Balance as of January 1, 1957	$1,307.81
Total Deposits for the year 1957	+ 335.30
	$1,643.11
Total expenditures for the year 1957	—1,095.00
Balance as of December 31, 1957	$ 548.11

LIST OF EXPENDITURES

January 1, 1957 to December 31, 1957

Date and Name	Description	Amount
February 25, 1957 American Mosquito Control Association, Inc.	Subscriptions to *Mosquito News* H. K. Lewis	$ 15.00
March 20, 1957 American Mosquito Control Association, Inc.	Subscriptions to *Mosquito News* L. B. Smith	55.00
August 15, 1957 Lester W. Smith	Treasurer AMCA	1,000.00
November 19, 1957 Fannie S. Raymond	Postage	25.00
TOTAL EXPENDITURES		$1,095.00

STATEMENT

December 31, 1957

Bulletin	Number of Books Sold	Accounts Paid	Accounts Outstanding
1 & 2	1524	$2,980.50	$77.50
3	774	1,432.00	94.00

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NEWS AND NOTES

AUSTIN W. MORRILL, JR.

WE TOLD YOU IT WOULD HAPPEN AND IT DID! When we brought the news of HARRY STAGE's new address, last fall, *News and Notes* successfully predicted that any address, however current, might not remain so for long. We were right! Our International Member may now be addressed at 423 Hutton Bldg., Spokane, Washington. Well, maybe we're fudging a little. It isn't much of a move, really, and he says it's only for week-ends right now, what with the busy season confronting him.

Harry also sent two interesting reports on recent conferences. One was a Short Course in mosquito control, held by Professor Harwood of the State College of Washington, at Pullman, on 6 and 7 May. Another was the mosquito control conference held in April at Othello, Washington. This latter was attended by 52 persons, including notables from nearby universities and health departments, as well as representatives of commercial concerns. Othello is the community where a mosquito abatement campaign was given impetus last year by a Junior Chamber of Commerce fund-raising drive that raised three hundred dollars for an immediate air spraying and apparently sparked what turned into the present seven-county system of mosquito control districts. The Washington State Department of Health's Bulletin, Vol. 1, No. 8, for October, 1957 describes this and has a fine layout of photographs illustrating the control activities and including one of our ever-youthful Harry helping to map out the work. The meeting incidentally utilized DON MURRAY's fine film on "The Pasture Mosquito," another instance of the way we mosquito control folks work hand in hand together all over.

OUR PRESIDENT, COMMANDER "MO" HIRST IS IN HAWAII, YOU THOUGHT, DIDN'T YOU? Well, he isn't. Like many another AMCAer, Mo has taken to rambling about over the globe. All strictly in his official duties, we hasten to say. He and Bill Cantelo, entomologist for the Navy on Guam, and a team of five, have been jaunting about over Japan, the Philippines, Taiwan, Okinawa and all that, and will probably just be getting back home when you read this. (Sigh!) All those lovely places!

DICK PETERS ANNOUNCES THAT HIS ORGANIZATION IS HAPPILY WELCOMING ALLEN RALPH BARR to the overall direction and coordination of the California Bureau of Vector Control's research program centered at Fresno. Dr. Barr has until now been Assistant Professor of Medical Entomology at the University of Kansas and his "Mosquitoes of Minnesota" is newly published by the University of Minnesota Press. It was illustrated by Ralph's wife.

Dick also tells us that *if* the Governor signs the State of California budget (as he is expected to do, we might add), the Bureau of Vector Control is to receive $50,000 for research on the control of gnats, which will be done via the *mosquito abatement districts*. This further points up the fact that the control of *all* noxious and vector insects is coming more and more to be considered by the public as an appropriate subject for mosquito abatement district consideration.

DON GRANT PREPARED FOR HIS BOARD OF TRUSTEES A REPORT ON THE MERITS OF TRUSTEE ATTENDANCE AT AMCA MEETINGS which is a real masterpiece and we wish we could print it here in full. However, his points are summarized as follows (Don's summary):

1. Conception of the total scope and varied aspects of mosquito control.
2. Understanding of organization and policies employed by similar agencies throughout the United States and the world.
3. Personal observation of slides, pictures, equipment, exhibits and demonstrations pertinent to mosquito control.
4. Knowledge of the cooperative work and benefits afforded by other types of agencies and commercial interests, and appraisal of advantages derived from inter-agency relationships in meeting mutual interests.
5. Direct discussion with other Trustees and workers which may aid in practical evaluation of personnel relationships, comparative views in analysing procedural efficiency and the significance of local problems which are often not for public release.

WE SHOULD TELL YOU MORE ABOUT THE FINE MEETINGS THE UTAH MOSQUITO ABATEMENT HELD IN OGDEN in March. Our note in the March issue was pretty brief and was written, in fact, *before* the meeting. We went ourselves and should report that the two days of sessions were filled with excellent reviews of work being done not only in Utah but also in Washington, California and elsewhere. The fact that good wildlife refuge management and good mosquito control are compatible was pointed out in one talk and Dr. George Knowlton discussed the place of education in the weapons of mosquito control. ARCHIE HESS and his cohorts of the Logan Field Station filled a session with a fine array of papers on evaluation of residual insecticides, studies of pasture irrigation practices in relation to mosquito control, the tests for resistance, use of traps and studies on

encephalitis transmission. A very well-rounded meeting, which was attended by some 350 persons.

ALSO AT THE MEETING we noted that ARCHIE was sporting his distinguished member's AMCA pin, as befits a president-elect, and HARRY was proudly wearing his Past-President's pin. We understand that MO HIRST got these pins up, and they looked fine.

INCIDENTALLY, it was pointed out that 80 percent of the people of Utah now enjoy protection from the ministrations (we guess that should be *through* the ministrations!) of mosquito abatement districts, and they are planning ahead to provide the more intensive work which will be required to take care of an expected 50 to 85 percent increase in population in the next ten years. A pretty good mark for others to shoot at!

GEORGE SIEMERS OF THE MOSQUITO CONTROL ASSOCIATION OF CLARENDON HILLS, ILLINOIS, sends in a letter which is pertinent at this time of year. From time to time we have run notes on accident potentials and legal liability in connection with adulticidal fogging operations. GEORGE writes that their association, which has been functioning for the past seven years with increasing success, has for the past two years made the practice of sending a letter to every family in their fogging area. This letter is also published in a local newspaper and in the magazine "Suburban Life," reaching more than 40,000 homes. "Although we larvicide farther afield," he writes, "our actual fogging operations are carried out in Clarendon Hills and Blackhawk Heights. Each year after the 'safety letter' was mailed, the kids virtually stopped playing in the fog. Local motorists are learning safety ways too. . . . We believe more safety publicity is not only necessary but vital." His letter asks that children be taught not to follow the fogging equipment, not to run in and out of the fog, not to ride bicycles and tricycles through the fog, either on the sidewalk or in the street, and that motorists trail along behind the fogger rather than try to pass it, or if in a hurry that they detour around the block. He'd like to hear from anyone with more ideas on safety in this situation, and so would we.

GEORGE THOMPSON SENDS HIS MARCH REPORT ON WORK IN HIS JEFFERSON COUNTY (TEXAS) MOSQUITO CONTROL DISTRICT, which emphasizes survey, thorough ground preparation prior to aerial spraying and the fundamental nature of environmental control measures, particularly ditch maintenance. As a result he was able to state that there was "no real heavy breeding," though some adulticiding was required. He reports his heaviest population was, at that time, *Culiseta inornata,* which was already tapering off, with *Culex* spp. coming second, followed by *Anopheles crucians.*

FROM "SKEETER," THE VIRGINIA MOSQUITO CONTROL ASSOCIATION'S LIVELY BI-MONTHLY PAPER, we learn that the exhibit which the Virginians created for the Washington, D. C. meetings with AMCA has been eliciting quite a popular response throughout their state, with requests for its showing coming in from cities as diverse in their settings as Roanoke in the mountains and Norfolk on the shore. The display consists of three panels, the middle panel 4 by 4 feet and the wing panels 2 by 4 feet, joined together by loose pin hinges so as to be readily disassembled. The general background of the panels is a light, neutral grey and a colored map of Tidewater Virginia, on plexiglass, is set in the middle panel. Brightly colored plaques representing the fifteen mosquito control districts are set around the central map and in each is a colored transparency of a photograph showing some phase of the work being done in the Old Dominion. Openings in the background panels permit light from lamps behind them to shine through these transparencies and the whole gives a very lively and colorful appearance. The Virginia Association has also prepared a bulletin entitled, "Mosquitoes and Their Control," for distribution by the various Commissions, and "Skeeter" proudly announces that copies have been furnished every school in Norfolk and to other schools as well, throughout the Norfolk-Portsmouth area.

ALSO FROM "SKEETER" BUT REALLY A NEWS ITEM FROM FLORIDA, we learn that a mixture consisting of 3 gallons of 90 percent malathion, 3 gallons of Lethane 384 and 94 gallons of No. 2 diesel fuel oil, is being recommended for fogging where there is hydrocarbon resistance. Is anyone else using this?

OTTO MCFEELY AND FRANK WRAY HAVE SENT OUT THEIR THIRTIETH ANNUAL REPORT OF THE DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT (ILLINOIS) covering 1957, and many of you have no doubt perused it with considerable interest and profit. Their comprehensive and attractively compiled report covers, among other things, such matters of general concern and speculation as the effects of flooding on populations, comparisons of treatments with mist sprayers and fog generators and the effect of DDT fog on goldfish. (Their conclusion on this last was that there isn't any.)

A LETTER FROM RUSS FONTAINE TO EARLE MORTENSON GIVES US RUSS' NEW ADDRESS IN ADDIS ABABA AND ONE TO DICK PETERS IS SO PACKED WITH INTERESTING MALARIA INFORMATION THAT IT OUGHT TO BE MADE INTO AN ARTICLE INSTEAD OF A NOTE. The address is U.S.O.M., % American Embassy, APO 319, Postmaster, New York, N. Y. Russ is living in the Ras Hotel in Addis, where his wife and boys have now joined him and they hope to locate a suitable dwelling very soon. At the time of writing Earle's letter, Russ had just completed a ten-day survey trip of some 2,000 kilometers, all but about 500 kilometers of

which were "fortunately by air." However, in Dick's letter a week or so later, Russ has lost some of his enchantment for air travel in Ethiopia, referring to the plane as being known locally as the "vomit comet." Inelegant but descriptive of many flights in many hinterlands.

We want to try to digest some of Russ' meaty letter, so here goes: "Malaria is probably the most important public health problem facing the nation. It's most severe in the fertile valleys with the greatest agricultural potential. In order to avoid infection, the people in these areas build their dwellings up on the high ridges and escarpments surrounding the valleys. They climb up to their dwellings before nightfall and move down again after sunrise to tend their cattle and their pitiful little gardens. In the broad valleys where the high places are many miles away, the people live with the disease as best they can.

"*P. falciparum* is the dominant species, but *vivax* and *malariae* make a good showing. The peak transmission season in the high plateau country occurs during and shortly following the rainy season which lasts from July through October. In other areas the rains come at other times or not at all in some desert areas. In other words, it's much like California. There's no set pattern to the climate throughout the country.

"*Anopheles gambiae* is the principal vector in most of Ethiopia according to the available information, which is far from being complete. There are about 12 other *Anopheles* species which may or may not be important. No one really knows very much about it so we have much entomological work to keep us busy in the future. The malaria situation is definitely one of natural origin, like the California problem prior to the advent of irrigation. The vectors are from the few swamps and lakes that exist in the country. As far as I can determine, there is nothing man-made about it. The people lead a simple, primitive existence and exert practically no control over their environment. Of course our job (ICA) is to help change this! Already irrigation projects are being initiated in some areas, roadways are being improved and extended, hospitals and schools constructed and so on."

Russ describes some of the other entomological problems, particularly flies and grasshoppers and goes on to say that both he and ROY FRITZ were bitten by tse-tse flies, Roy in a somewhat tender spot while laundering his sox in a shower. Neither Russ nor Roy got anything from the flies but we bet the flies got something from Roy!

ED SMITH HAS WRITTEN A LETTER TO DICK PETERS, Too, to which he has added a postscript that he is now en route home but will stop off at Jamaica for a three months' malaria eradication training course, so that he will get to California in the middle of August. He plans to return to Djakarta and says that the Indonesian Government has pled strongly with DON REES to extend *his* tour, which Don would sort of like to do but feels duty bound to return to his obligations in Utah, too. Ed says he and Don surely wished they could be in Washington (as did many of us chained to desks here in the little old prosaic U.S.A., Ed!) and also wish AMCAers could get out there to visit . . . and to help. Ed, Don and others have formed an entomological-parasitological society which is flourishing vigorously. He says that the revolutions and counter-revolutions are—so far—paper ones, but goes on to say, "Not many dull moments so far. Involved in the program are: 7,000 employees, 180 local programs (each Regency is roughly equivalent to a local mosquito district), 82 million people, a multi-million dollar budget, 90 odd anophelines, 3 thousand islands, from 13 to 17 provinces, depending on who is doing the counting." He says he also has "played bingo with the numbers called in Indonesian, Dutch, German, and in English for my benefit, visited a Dyak village where 100 percent of the men, women and children suffer from malaria in any given year, had a meal served by waiters carrying Bren guns and hand grenades, listened to machine-gun and rifle fire for 2½ hours during the middle of the night while on a week-end in the mountains . . . drunk arrack, tuak and brum Bali" and a good deal more. Are you still all in one piece, Ed?

ACCORDING TO PRESIDENT MO, THE FLORIDA ANTI-MOSQUITO ASSOCIATION HELD ITS ANNUAL MEETING at the Fort Harrison Hotel, Clearwater, Florida, from 27 through 30 April, 1958, thus answering our query of last issue. Also from Mo comes the report that the Illinois Mosquito Association meeting, which *California Vector Views* had predicted, took place all right at the University of Illinois in Urbana on 6 and 7 February. "At the Illinois meetings the program was star-studded with well known authorities," writes Mo, "which included Dr. Bailey B. Pepper, Rutgers University, LCDR F. R. DuChanois, M.S.C., U.S.N.R., Mr. P. Bruce Brockway, Jr., and Mr. Robert L. Vannote."

ED WASHBURN'S ELEVENTH ANNUAL REPORT OF THE TURLOCK (CALIFORNIA) MOSQUITO ABATEMENT DISTRICT contains pages and pages of good data on costs of various types of operations. As in previous years, Ed breaks his figures down to specific materials and methods and the conclusions are very enlightening. Obviously, airplane spraying isn't practicable or desirable for all situations, but it is interesting that Ed's figures show it to be only a little more than half as expensive as power spraying and this, in turn, is less than a third as costly as hand operations. In 1957, Ed did no fogging, using the time gained to extend inspection and source reduction. This latter, for Ed, is largely concerned with proper use of irrigation water, which farmers are beginning to appreciate now as a factor in good crops as well as mosquito control, and Ed also has some 80 miles of rivers with dense undergrowth. He also found time to gain the cooperation of the public in

eliminating over two-thirds of the backyard breeding sources uncovered by his inspectors. Altogether a busy year.

BY A STRANGE COINCIDENCE, THE NAME OF OUR LEAD-OFF MAN IN WHO'S WHO IN A.M.C.A. THIS TIME HAS ALREADY BEEN MENTIONED EARLIER IN THIS COLUMN. However, we'll give you a few more delicate little hints. This gent was born in Toledo, Ohio, where one of our distinguished members, Bruce Brockway, now resides. (Wonder if they know each other?) This event took place in 1915, and his education was accomplished, he says, by Albion College, Toledo University and the School of Hard Knocks. He has been a member of AMCA for 15 years, which makes him an Early Member, and his hobbies are variously gardening, photography and Doberman Pinscher dogs. He spent 6 years with the U. S. Navy on malaria control being first in the South Pacific in March of 1942. In 1945 he was with the Medical Research Unit No. 2 on Guam, right in the middle of a few years of violent mosquito revolution on that Island, when a number of AMCA experts took licks at the situation. He's been the superintendent of the Toledo Area Sanitary District for the past five years . . . what? We gave it away? Shux, so we did. Well, folks, this here's P. Bruce Brockway, Jr. We only had two more things to say about him. Before he was Super, he was Field Super of the Toledo District for eight years, so as we all know, he's an Old Hand at this stuff. And he has two boys, Porter Bruce III, who is seven, and Louis Herman, who is three. We'll bet they can both identify their mosquitoes already.

OUR NEXT NOTABLE IS ALSO AN OLD HAND, HAVING BEEN WITH US TWELVE YEARS, and in mosquito control for 14 years, 10 of them as manager of the Mosquito Abatement District of a very large county in California. He was born in Riverside, California, in 1911 and went to Junior College there before going on to the University of Arizona and the University of California at Davis and Berkeley. He has been Sanitarian for the health departments in San Luis Obispo, Riverside, Kern, and Tulare Counties and with the State health department. He has two children, too, a son, Douglas, and a daughter, Joanne, and his hobbies are fishing (and sometimes golf). Who? ART GEIB!

ONE OF OUR MOST REMARKABLE MEMBERS AND ONE UNIVERSALLY ADMIRED FOR HIS ABILITY IN MOSQUITO CONTROL HAS SO VARIED AND COLORFUL A BACKGROUND THAT WE BRING IT TO YOU JUST AS HE JOTTED IT DOWN. He was born in Pershing, Oklahoma, in March of 1920 and graduated from high school in Omaha (hold it!) Arkansas. His civilian occupations have been farmer, grocer, butcher, lumberjack, school teacher, service station attendant, truck driver, mechanic, railway telegrapher, insurance investigator, wine cellar foreman, public weighmaster, radio repairman, carpenter and mosquito abatement. He is too modest to add "expert" but we will do so. We are glad that he finally found his niche in mosquito abatement, where he no doubt finds some of all that background useful in running a program which includes use of several radio-controlled vehicles and an airplane or two. His military background, also varied, includes radio operator, mechanic and engineer, communications chief, U.S.A.F., and overseas duty with the military mission in Moscow. With all this, he also got a sanitary engineering degree from the I.C.S. and for five years has been applying everything to an expanding and challenging mosquito abatement problem in a district of rapidly growing population. Oh, didn't we tell you who we're talking about? It's JOHN BRAWLEY, of the Kings County (California) Mosquito Abatement District.

DICK BOHART WAS BORN IN PALO ALTO, CALIFORNIA BUT WENT TO CAL ANYWAY and received there (in Berkeley) his B.S., M.S. and Ph.D. He is presently Associate Professor of Entomology at his Alma Mater's Davis campus and in between was at U.C.L.A., in Los Angeles, and with the Navy. He was LCDR there in the U.S.N.R. and says he still has a sentimental regard for it, as well he might, for his Navy bulletin on the "Mosquitoes of Okinawa and the Islands of the Central Pacific" and "The Mosquitoes of Japan and Their Medical Importance" were Bibles to dozens of us in mosquito control in those parts. He spent most of 1945 on Guam and Okinawa, etc., and also was back there for seven months in 1951 under the auspices of the Pacific Scientific Board, the Office of Naval Research and the Department of the Army. As we all know he has published quite a bit on the mosquitoes of this part of the world. Dick has been a member of AMCA since 1947 and has been teaching 15 years, so we'll call him an Old Timer, too. He's one of the few real pure, high-minded taxonomists we know who can manage to make systematics and the tortuous complexities of nomenclatural orthodoxy sound both rational and practical. His talk on this at the California Association meetings went a long way toward reconciling many of us to the necessities of this rocky road, which field men are often apt to want to brush aside, we find. (Anyone for mixed metaphors?) Anyway, Dick's one of our many members who mix erudition with practical ability. He lists his hobbies, single-mindedly, as insect collecting in all phases.

THOSE WHO HAVE KNOWN ONE OF OUR NEWER MEMBERS, CORNELIO M. URBINO, in the Division of Malaria of the Department of Health in Manila, will be interested in a letter recently received from him. He writes, "I have been busy lately, because of the implementation of the surveillance program that naturally accompanies our malaria control. In addition to this, I am also working in the control of axil breeding mosquitoes that transmit filaria. I have tried dusting,

spraying and fogging with various insecticides. So far, spraying with DN or DDT is the best."

A LETTER FROM GEORGE BURTON, WHICH ARRIVED JUST AS WE WERE PUTTING THIS IN THE MAIL, informs us that his next assignment is as advisor on Filariasis to the Technical Cooperation Mission, % American Embassy, New Delhi, India. His main headquarters will be at the Institute of India, in Delhi, with field headquarters in south India, at Ernakulam near Cochin, Travancore, Kerala area, near the southwest tip. Sounds like a live problem and an interesting place to work on it, George!

THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION'S SECOND ANNUAL ENTOMOLOGY SEMINAR was very successfully held on 28 and 29 March at the Fresno State College campus, with forty-eight members in attendance. The group included managers, entomologists and other technical people from mosquito abatement districts, county health departments, the State Bureau of Vector Control, the United States Department of Health, Education and Welfare, the United States Navy and various colleges and universities. An opportunity was afforded for all present to join in the discussions, each of which was led by a well-qualified moderator whose opening and stimulating remarks were scarcely needed to start the discussions rolling. Discussions from the floor can sag badly sometimes, but none of these did, even for a moment. DON MURRAY led the discussion of "Mosquito Control when the Environment Changes," which brought up the problem of creating a *new* problem while controlling an old one; ART SMITH gave aid and comfort to those who are concerned with fighting flies of public health importance; BUCK BELLAMY and DICK HUSBANDS led the discussion of "Mosquito Colonies," including the use and value of colonies, membrane feeding of arthropods, autogenous colonies, and such esoterica; and DICK BOHART gave a lucid and sympathy-arousing discourse on the troubles of workers in mosquito nomenclature. DICK's talk was the only one which got no back-talk, largely because no one felt qualified to argue with Dick, but he did get a lot of lively interest and many questions from us peasants. Dick was quick to point out that taxonomists were caught in the same toils as the rest of us: no solution is satisfactory, yet order must be maintained somehow. A dinner meeting was also held, at which BRYANT REES presented some magnificent color slides of a trip down the Colorado River, rugged but beautiful. The meetings were under the auspices of the Entomology Committee, headed by LEON HALL, and will be held next year at Riverside.

ANNOUNCEMENT

The South Cook County Mosquito Abatement District is accepting applications from qualified candidates for the position of Field Engineer. Experience in dragline and dozer work is desirable and the applicant should be eligible for Illinois registration. The appointee will supervise the field engineering program and salary will be commensurate with qualifications and experience, in excess of $8,000 per year for an experienced man, plus transportation, liberal vacation allowance, Blue Cross-Blue Shield, etc.

Applicants should write to the District, P. O.
Box 30, Harvey, Illinois.—W. J. Buchanan, Engineer-Manager.

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Errata

In volume 17(3):227 of Mosquito News, section on Distribution under Colless, change pages 102–120 to read 102–116. In volume 18(1):44, section on Biology and Ecology under Hecht and Corzo, change Ztschr. u. Parasitol. to read Ztschr. f. Tropenmed. u. Parasitol.

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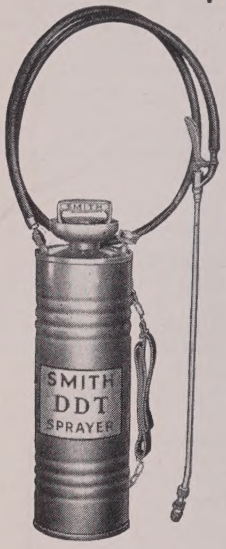

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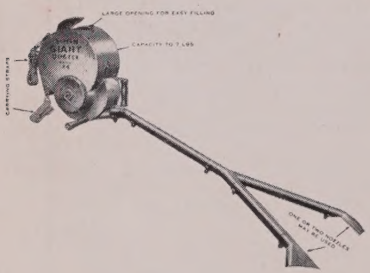

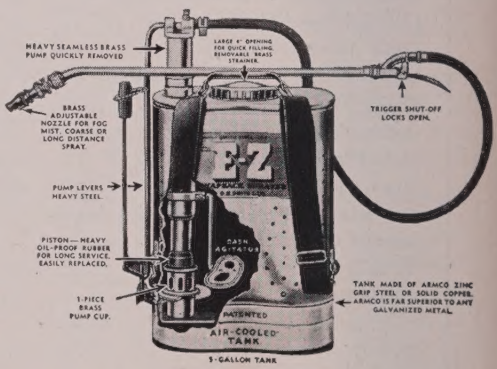
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